BARBER COLMAN COMPANY

Single Time-Proportioning Switching Output Controllers Models 522B, 523B, and 524B

INSTRUCTION MANUAL

The complete Instruction Manual for this Controller consists of the following pieces of literature.

Number	Section	Name
1252 IN 22	1	Description, Specifications, and Operation
1252 IN 17	2	Installation & Wiring
F-14851	3	Main Board Circuits and Calibration (Includes Wiring and Replaceable Mechanical Parts)
F-15675	3	Digital Indicator Supplement
F-16198	4	Isolation Board
F-16199	5	Troubleshooting Main Board and Range Boards, Changing Ranges
F-16200	6	Alarm Boards Circuit Description & Service
F-14852	7	Control Mode Boards Circuit Description & Service
F-14854	8	Output Boards Circuit Description & Service

IGNORE MATERIAL NOT APPLICABLE TO YOUR MODEL

AFTER UNPACKING

COMPARE THE CONTENTS OF THE SHIPPING CONTAINER WITH THE PACKING SLIP. IF A DISCREPANCY OCCURS, NOTIFY THE FACTORY IMMEDIATELY. IF THE CONTROLLER IS DAMAGED IN SHIPMENT, REPORT THE EXTENT OF THE DAMAGE TO THE CARRIER.

1.1 Description

Controller Models 522B, 523B, and 524B have solid state switching outputs capable of 10 Amperes Inrush and 1 Ampere Continuous. Any voltage from 24 Vac to 240 Vac can be switched. Electromechanical contactors up to 100A or the Barber-Colman Series CB11 and CB13 Solid State Contactors can be switched. These models have single Time Proportioning switching outputs; and a Cycle Time which can be adjusted from 6 to 60 seconds nominal by means of the front panel CYCLE control. By removing one component, Cycle Time can be changed to adjust from 0.6 to 6 seconds (nominal) for optimum control of a solid state contactor.

The Series 520 is a modular controller designed to accept the output of a standard Barber-Colman thermocouple, resistance bulb, radiation pyrometer, or other millivolt source. Process variables such as temperature or pressure may be monitored either by a Deviation Meter or by a Process Meter. With either of these meters a 1-5 Vdc output signal for remote metering of a process can be specified. The front panel Digital Setpoint has either three or four digits depending upon the range. The thumbwheel switches of the SETPOINT can repeat settings within a resolution of 1°. An Analog Setpoint dial is marked with the range specified.

The plug-in design of this modular controller reduces down time by allowing quick replacement of either the controller or one of it modules.

Three control modes are available; namely, Proportional, Proportional plus Integral (Automatic Reset), and Proportional plus Integral plus Derivative (Rate).

A controller with the Proportional mode only has Gain and Manual Reset adjusted by the front panel GAIN and RESET controls, respectively. Manual Reset action is applied to the output of the controller to prevent offset (droop). Manual Reset action is satisfactory when load changes are rare.

A controller with the Proportional plus Integral mode has the Gain and Integral actions adjusted by the front panel GAIN and RESET controls, respectively. Integral action of the controller prevents offset in operation where severe and frequent load changes occur. Reset Windup Inhibition is included with this control mode to control overshoot by inhibiting reset action during warmup time. Reset Windup Inhibition is particularly desirable in batch processes where large step increases or decreases are likely to occur.

A controller with the Proportional plus Integral plus Derivative mode has Derivative action continuously adjustable by the RATE control from 0 to 3 minutes. Derivative action is available for processes where sudden upsets, appreciable transfer lag, or a small to moderate amount of dead time is present. Derivative action corrects the controller output proportional to the speed of change of a deviation.

1.2 Specifications

Input Signal A *thermocouple* span of 10mVdc or greater. Thermocouple inputs have cold junction compensation. Total resistance of thermocouple and leadwire may be up to 200 ohms. A source resistance up to 1000 ohms may be accepted with less than ±1.5% calibration shift.

Two wire *RTD* (resistance temperature detector) with nominal resistance from 100 to 1000 ohms. Minimum span is 10% of the nominal resistance. Standard ranges available for 100 ohm platinum elements with a temperature coefficient of .00385 ohm/ohm/°C.

Current spans from 1 to 50mAdc. 100mV drop.

Millivolt spans from 10 to 100mVdc. Input resistance greater than one megohm.

Voltage spans above 0.1 Vdc. 0.1 to 1 Vdc, 5k ohms input impedance. 1 to 10 Vdc, 50k ohms input impedance.

Radiation Pyrometer spans from 14 to 100mVdc, with an emissivity ratio adjustment from 0.7 to 1. Up to 20k ohms input resistance.

Thermocouple Break Action Upscale (standard) or downscale break action.

Input Reference Input may be referenced to ground or may be floating.

Setpoint *Digital Setpoint* selectable on a three or four digit register by adjusting thumbwheel switches. Settings can be repeated exactly. Minimum digital span: 399 digits.

Analog Setpoint selectable on a 5 inch scale.

Readouts Calibration depends on instrument span.

Deviation Meter: Displays difference between process signal and setpoint.
1.125 inch scale (standard), calibrated ±10, 30, 50, 100 or 200.
1.8 inch scale (optional), calibrated ±5, 10, 25, 50 or 100.

Analog Process Meter: Process signal indicated over full span.

Digital Process Meter: Process signal indicated in bright red 0.362 inch high numerals with Light Emitting Diodes (LED). Any range from -4000 to +19999 can be displayed.

Solid State Switching Output 1A continuous, 10A inrush, 50 mA minimum. Any voltage from 24 Vac to 240 Vac can be switched, but the voltage must be the same phase and have the same common line as the instrument power supply.

Cycle Time Adjustable from 6 to 60 seconds (nominal) by the CYCLE control. By removing capacitor C3 on the output board, cycle time can be changed to adjust from 0.6 to 6 seconds (nominal) for optimum control of a process with a solid state contactor. Refer to Output Section 8 of this manual for location of this capacitor.

Alarms Alarm trip point is set by the ALARM control. Alarm can be set to trip from either an increasing or a decreasing signal as follows.

Deviation: 0 to ±25% of span about setpoint.

Deviation Band Alarm: From + and - 1.5% up to + and - 25% of span. 50% maximum bandwidth.

Process: 0 to 100% of span.

Alarm Relay Contact Rating 2A at 120 Vac, resistive.

Gain (Proportional Band) For instruments with Proportional action only, the GAIN control is adjustable from 10 to 100. For instruments with Proportional plus Integral action, the GAIN control is adjustable from 1 to 100. At a setting of 1, the proportional bandwidth is 100% of span; at 10, 10% of span; and at 100, 1% of span. Derivative (Rate) action does not affect Gain (Proportional Band).

Manual Reset Action Continuously adjustable by RESET control from 0 to 100% output at zero deviation (null).

Integral (Automatic Reset) Action Continuously adjustable by RESET control from 0.06 to 6 repeats per minute. When RESET control is fully CCW (click off), Integral action is turned OFF.

Reset Windup Inhibition Inhibition circuit reduces reset term to zero when the Demand Signal reaches maximum positive limit of proportional band.

Derivative (Rate) Action Continuously adjustable by RATE control from 0 to 3 minutes.

Reference Accuracy ±0.5% of span.

Reference Operating Conditions
Ambient Temperature: 25°C (77°F).

Operating Power Supply: 120 or 240 Vac, ±1%, 50 or 60 Hz.

Source Resistance (TC ranges only): 10 ohms.

Rated Accuracy ± (1% of span plus 0.5% of suppression).

Rated Operating Conditions
Ambient Temperature: 5 to 55°C (40 to 130°F).

Operating Power Supply: 120 or 240 Vac, ±10%, at 60 Hz; or 110 or 220 Vac, ±10%, at 50 Hz, by rear terminal selection.

Humidity: 0-70% RH.

Position (tilt): Any position.

Common Mode Rejection (CMR): 140 decibel.

Maximum Common Mode Voltage: 120 Vac r.m.s.

Series Mode Rejection (SMR): 70 decibel.

Maximum Series Mode Voltage: 5 times span.

Source Resistance (TC ranges only): 0-200 ohms.

Storing Temperature -40 to +66°C (-40 to +150°F).

Frequency Response Direct current to 0.7 Hz in the Proportional action only controllers. Depends on setting of RESET control in Proportional plus Integral action controllers.

Line Voltage Stability 10% change in line voltage will not shift control by more than 0.1% of span.

Temperature Stability
4 microvolts per °F, maximum.
2 microvolts per °F, typical.

Sensitivity 0.00075% of span for 100% change in output.

Isolation Fully isolated.

Isolated Remote Setpoint Voltage (Setpoint Option 2 or 5)
1-5 Vdc. Source should be free of transients and have an

impedance less than 200 ohms. For operation of more than one controller from the same external source, a source resistance under 50 ohms is recommended. Input impedance is 1M ohms, typical.

Isolated Trim Setpoint (Setpoint Option 8) Requires 1-5 Vdc Setpoint voltage from an external source. Source resistance up to 20 ohms. Trim control adjusts the instrument Setpoint ±5% of span. Input impedance is 20k ohms.

Isolated Output Setpoint Voltage (Setpoint Option 3 or 6) 1-5 Vdc proportional to instrument Setpoint span. Short circuit has no effect on control action. Source resistance less than 10 ohms.

Maximum total output current of Process Signal Output option plus Output Setpoint Voltage option is 10mAdc.

Isolated Process Signal (Setpoint Option 2, 3, 5, 6, 7 or 8) 1-5 Vdc on rear panel terminals. External short circuit has no effect on control action. Source resistance less than 10 ohms.

Maximum total output current of Process Signal Output option plus Output Setpoint Voltage option is 10mAdc.

Power Consumption 7VA.

Shipping Weight 1.8 kg (4 lbs.).

1.3 Operation

1.3.1 FRONT PANEL CONTROLS AND INDICATORS

SETPOINT Control for selecting the nominal Setpoint temperature.

Amber Lamp Located on left side of upper front panel. Glows when the output switch is ON.

Red Alarm Lamp (Optional Auxiliary Alarm) Located on right side of upper front panel. Steady glow indicates an alarm condition.

ALARM Control on Main Board (Optional Auxiliary Alarm) Adjustment potentiometer for selecting Alarm trip point.

Deviation Alarm: 0 to 25% of span about Setpoint.

Deviation Band Alarm: From + and - 1.5% up to + and -25% (fully CW) of span. 50% maximum bandwidth.

Process Alarm: 0-100% (fully CW) of span.

GAIN Control on the Main Board Single turn potentiometer for selecting Gains of 10 (fully CCW) to 100 (fully CW) for Proportional action only controllers; and, from 1 (fully CCW) to 100 (fully CW) for Proportional plus Integral action controllers. At a setting of 1, the Proportional Bandwidth is 100% of span; at 10, 10% of span; and, at 100, 1% of span. Derivative (Rate) action does not affect the Gain (Proportional Band).

Manual RESET Potentiometer on Control Mode Board (Model 522B) Single turn potentiometer for selecting 0 (fully CCW) to 100% (fully CW) output at null with the GAIN pot set at 10 (fully CCW). Requires narrower adjustment range for higher gains.

Integral RESET Potentiometer on Control Mode Board (Models 523B and 524B) Single turn dual potentiometer and switch for selecting .06 to 6 (fully CW) repeats per minute. When fully CCW (click off), Integral action (Automatic Reset) is turned OFF.

Derivative RATE Potentiometer on Control Mode Board (Model 524B) Single turn potentiometer for selecting a Derivative (Rate) time from 0 (fully CCW) to 3 (fully CW) minutes.

CYCLE Control on Output Board Single turn potentiometer for selecting a Cycle Time from 6 (fully CW) to 60 (fully CCW) seconds.

LOCAL-REMOTE Switch (Setpoint Option 2 or 5) When Setpoint Option 2 or 5 is specified, the red Alarm lamp is replaced by the two position LOCAL-REMOTE switch. In the REMOTE position (down) the controller receives an external Setpoint on rear panel terminals 4 and 5. In the LOCAL position (up) the Setpoint is determined by the SETPOINT control below the switch.

TRIM Control (Setpoint Option 8) Single turn potentiometer for decreasing a Remote Setpoint voltage -5% of span (fully CCW) to increasing the Remote Setpoint voltage +5% of span (fully CW). TRIM control is marked -5, -4, -3, -2, -1, 0, 1, 2, 3, 4, and 5 in Percent of Span. When Setpoint Option 8 is specified the TRIM control replaces the front panel SETPOINT control.

1.3.2 PRELIMINARY ADJUSTMENTS

It may be necessary to operate the process equipment to make preliminary adjustments on it and also, for example, to dry out furnace liner material. During any preliminary operation, turn the RESET control fully CCW to its OFF position. Turn the GAIN control fully CCW to minimum Gain (maximum Proportional Band). Now adjust the SETPOINT control as desired.

Always make a permanent record of any final settings for a specific process so that if the controls are changed for any reason, the original settings can be duplicated. Upsets can be simulated by turning the SETPOINT control to different settings, with the degree of upset desired proportional to the change in setting. Allow enough time, when making adjustments, for the system to stabilize. Remember that optimum controller adjustments are those that produce satisfactory results in a stable system. Optimum adjustments are not necessarily the finest and most sensitive settings that can be obtained.

1.3.3 MODEL 522B CONTROLLER WITH PROPORTIONAL ACTION ONLY

With Proportional action only, the output is a proportional correction signal for returning the process variable to the Setpoint selected on the SETPOINT control. The amount of amplification is selected by the operator on the GAIN control. At fully CW Gain is 100 (maximum), the Proportional Bandwidth is minimum. At fully CCW Gain is 10 (minimum), the controller Proportional Bandwidth is maximum. Set the GAIN control high enough to produce a stable process condition, but no higher. If there is excessive overshoot of the Setpoint or more than minimum recovery time from a step change in the process variable, reduce the Gain to obtain minimum recovery time. With Proportional action only there may be an offset (droop) of the measured variable from the Setpoint selected on the SETPOINT control.

The process should be stabilized (zero deviation) at the selected Setpoint.

1. If offset is below zero deviation, turn the RESET control CW one mark and allow time for the process to stabilize. Continue CW rotation in this manner until the process stabilizes.

1.2 Specifications

Input Signal A *thermocouple* span of 10mVdc or greater. Thermocouple inputs have cold junction compensation. Total resistance of thermocouple and leadwire may be up to 200 ohms. A source resistance up to 1000 ohms may be accepted with less than ±1.5% calibration shift.

Two wire *RTD* (resistance temperature detector) with nominal resistance from 100 to 1000 ohms. Minimum span is 10% of the nominal resistance. Standard ranges available for 100 ohm platinum elements with a temperature coefficient of .00385 ohm/ohm/°C.

Current spans from 1 to 50mAdc. 100mV drop.

Millivolt spans from 10 to 100mVdc. Input resistance greater than one megohm.

Voltage spans above 0.1 Vdc. 0.1 to 1 Vdc, 5k ohms input impedance. 1 to 10 Vdc, 50k ohms input impedance.

Radiation Pyrometer spans from 14 to 100mVdc, with an emissivity ratio adjustment from 0.7 to 1. Up to 20k ohms input resistance.

Thermocouple Break Action Upscale (standard) or downscale break action.

Input Reference Input may be referenced to ground or may be floating.

Setpoint *Digital Setpoint* selectable on a three or four digit register by adjusting thumbwheel switches. Settings can be repeated exactly. Minimum digital span: 399 digits.

Analog Setpoint selectable on a 5 inch scale.

Readouts Calibration depends on instrument span.

Deviation Meter: Displays difference between process signal and setpoint.
1.125 inch scale (standard), calibrated ±10, 30, 50, 100 or 200.
1.8 inch scale (optional), calibrated ±5, 10, 25, 50 or 100.

Analog Process Meter: Process signal indicated over full span.

Digital Process Meter: Process signal indicated in bright red 0.362 inch high numerals with Light Emitting Diodes (LED). Any range from -4000 to +19999 can be displayed.

Solid State Switching Output 1A continuous, 10A inrush, 50 mA minimum. Any voltage from 24 Vac to 240 Vac can be switched, but the voltage must be the same phase and have the same common line as the instrument power supply.

Cycle Time Adjustable from 6 to 60 seconds (nominal) by the CYCLE control. By removing capacitor C3 on the output board, cycle time can be changed to adjust from 0.6 to 6 seconds (nominal) for optimum control of a process with a solid state contactor. Refer to Output Section 8 of this manual for location of this capacitor.

Alarms Alarm trip point is set by the ALARM control. Alarm can be set to trip from either an increasing or a decreasing signal as follows.

Deviation: 0 to ±25% of span about setpoint.

Deviation Band Alarm: From + and - 1.5% up to + and - 25% of span. 50% maximum bandwidth.

Process: 0 to 100% of span.

Alarm Relay Contact Rating 2A at 120 Vac, resistive.

Gain (Proportional Band) For instruments with Proportional action only, the GAIN control is adjustable from 10 to 100. For instruments with Proportional plus Integral action, the GAIN control is adjustable from 1 to 100. At a setting of 1, the proportional bandwidth is 100% of span; at 10, 10% of span; and at 100, 1% of span. Derivative (Rate) action does not affect Gain (Proportional Band).

Manual Reset Action Continuously adjustable by RESET control from 0 to 100% output at zero deviation (null).

Integral (Automatic Reset) Action Continuously adjustable by RESET control from 0.06 to 6 repeats per minute. When RESET control is fully CCW (click off), Integral action is turned OFF.

Reset Windup Inhibition Inhibition circuit reduces reset term to zero when the Demand Signal reaches maximum positive limit of proportional band.

Derivative (Rate) Action Continuously adjustable by RATE control from 0 to 3 minutes.

Reference Accuracy ±0.5% of span.

Reference Operating Conditions
Ambient Temperature: 25°C (77°F).

Operating Power Supply: 120 or 240 Vac, ±1%, 50 or 60 Hz.

Source Resistance (TC ranges only): 10 ohms.

Rated Accuracy ± (1% of span plus 0.5% of suppression).

Rated Operating Conditions
Ambient Temperature: 5 to 55°C (40 to 130°F).

Operating Power Supply: 120 or 240 Vac, ±10%, at 60 Hz; or 110 or 220 Vac, ±10%, at 50 Hz, by rear terminal selection.

Humidity: 0-70% RH.

Position (tilt): Any position.

Common Mode Rejection (CMR): 140 decibel.

Maximum Common Mode Voltage: 120 Vac r.m.s.

Series Mode Rejection (SMR): 70 decibel.

Maximum Series Mode Voltage: 5 times span.

Source Resistance (TC ranges only): 0-200 ohms.

Storing Temperature -40 to +66°C (-40 to +150°F).

Frequency Response Direct current to 0.7 Hz in the Proportional action only controllers. Depends on setting of RESET control in Proportional plus Integral action controllers.

Line Voltage Stability 10% change in line voltage will not shift control by more than 0.1% of span.

Temperature Stability
4 microvolts per °F, maximum.
2 microvolts per °F, typical.

Sensitivity 0.00075% of span for 100% change in output.

Isolation Fully isolated.

Isolated Remote Setpoint Voltage (Setpoint Option 2 or 5)
1-5 Vdc. Source should be free of transients and have an

impedance less than 200 ohms. For operation of more than one controller from the same external source, a source resistance under 50 ohms is recommended. Input impedance is 1M ohms, typical.

Isolated Trim Setpoint (Setpoint Option 8) Requires 1-5 Vdc Setpoint voltage from an external source. Source resistance up to 20 ohms. Trim control adjusts the instrument Setpoint ±5% of span. Input impedance is 20k ohms.

Isolated Output Setpoint Voltage (Setpoint Option 3 or 6) 1-5 Vdc proportional to instrument Setpoint span. Short circuit has no effect on control action. Source resistance less than 10 ohms.

Maximum total output current of Process Signal Output option plus Output Setpoint Voltage option is 10mAdc.

Isolated Process Signal (Setpoint Option 2, 3, 5, 6, 7 or 8) 1-5 Vdc on rear panel terminals. External short circuit has no effect on control action. Source resistance less than 10 ohms.

Maximum total output current of Process Signal Output option plus Output Setpoint Voltage option is 10mAdc.

Power Consumption 7VA.

Shipping Weight 1.8 kg (4 lbs.).

1.3 Operation

1.3.1 FRONT PANEL CONTROLS AND INDICATORS

SETPOINT Control for selecting the nominal Setpoint temperature.

Amber Lamp Located on left side of upper front panel. Glows when the output switch is ON.

Red Alarm Lamp (Optional Auxiliary Alarm) Located on right side of upper front panel. Steady glow indicates an alarm condition.

ALARM Control on Main Board (Optional Auxiliary Alarm) Adjustment potentiometer for selecting Alarm trip point.

Deviation Alarm: 0 to 25% of span about Setpoint.

Deviation Band Alarm: From + and - 1.5% up to + and -25% (fully CW) of span. 50% maximum bandwidth.

Process Alarm: 0-100% (fully CW) of span.

GAIN Control on the Main Board Single turn potentiometer for selecting Gains of 10 (fully CCW) to 100 (fully CW) for Proportional action only controllers; and, from 1 (fully CCW) to 100 (fully CW) for Proportional plus Integral action controllers. At a setting of 1, the Proportional Bandwidth is 100% of span; at 10, 10% of span; and, at 100, 1% of span. Derivative (Rate) action does not affect the Gain (Proportional Band).

Manual RESET Potentiometer on Control Mode Board (Model 522B) Single turn potentiometer for selecting 0 (fully CCW) to 100% (fully CW) output at null with the GAIN pot set at 10 (fully CCW). Requires narrower adjustment range for higher gains.

Integral RESET Potentiometer on Control Mode Board (Models 523B and 524B) Single turn dual potentiometer and switch for selecting .06 to 6 (fully CW) repeats per minute. When fully CCW (click off), Integral action (Automatic Reset) is turned OFF.

Derivative RATE Potentiometer on Control Mode Board (Model 524B) Single turn potentiometer for selecting a Derivative (Rate) time from 0 (fully CCW) to 3 (fully CW) minutes.

CYCLE Control on Output Board Single turn potentiometer for selecting a Cycle Time from 6 (fully CW) to 60 (fully CCW) seconds.

LOCAL-REMOTE Switch (Setpoint Option 2 or 5) When Setpoint Option 2 or 5 is specified, the red Alarm lamp is replaced by the two position LOCAL-REMOTE switch. In the REMOTE position (down) the controller receives an external Setpoint on rear panel terminals 4 and 5. In the LOCAL position (up) the Setpoint is determined by the SETPOINT control below the switch.

TRIM Control (Setpoint Option 8) Single turn potentiometer for decreasing a Remote Setpoint voltage -5% of span (fully CCW) to increasing the Remote Setpoint voltage +5% of span (fully CW). TRIM control is marked -5, -4, -3, -2, -1, 0, 1, 2, 3, 4, and 5 in Percent of Span. When Setpoint Option 8 is specified the TRIM control replaces the front panel SETPOINT control.

1.3.2 PRELIMINARY ADJUSTMENTS

It may be necessary to operate the process equipment to make preliminary adjustments on it and also, for example, to dry out furnace liner material. During any preliminary operation, turn the RESET control fully CCW to its OFF position. Turn the GAIN control fully CCW to minimum Gain (maximum Proportional Band). Now adjust the SETPOINT control as desired.

Always make a permanent record of any final settings for a specific process so that if the controls are changed for any reason, the original settings can be duplicated. Upsets can be simulated by turning the SETPOINT control to different settings, with the degree of upset desired proportional to the change in setting. Allow enough time, when making adjustments, for the system to stabilize. Remember that optimum controller adjustments are those that produce satisfactory results in a stable system. Optimum adjustments are not necessarily the finest and most sensitive settings that can be obtained.

1.3.3 MODEL 522B CONTROLLER WITH PROPORTIONAL ACTION ONLY

With Proportional action only, the output is a proportional correction signal for returning the process variable to the Setpoint selected on the SETPOINT control. The amount of amplification is selected by the operator on the GAIN control. At fully CW Gain is 100 (maximum), the Proportional Bandwidth is minimum. At fully CCW Gain is 10 (minimum), the controller Proportional Bandwidth is maximum. Set the GAIN control high enough to produce a stable process condition, but no higher. If there is excessive overshoot of the Setpoint or more than minimum recovery time from a step change in the process variable, reduce the Gain to obtain minimum recovery time. With Proportional action only there may be an offset (droop) of the measured variable from the Setpoint selected on the SETPOINT control.

The process should be stabilized (zero deviation) at the selected Setpoint.

1. If offset is below zero deviation, turn the RESET control CW one mark and allow time for the process to stabilize. Continue CW rotation in this manner until the process stabilizes.

2. If offset is above zero deviation, turn the RESET control CCW one mark and allow time for the process to stabilize. Continue CCW rotation in this manner until the process stabilizes.

1.3.4 MODEL 523B CONTROLLER WITH PROPORTIONAL PLUS INTEGRAL ACTION

The following procedure gives initial settings that represent a compromise between close control of minor process upsets and good recovery from large upsets. Allow plenty of time for the process to stabilize after each adjustment. Proceed as follows:

1. Turn the GAIN control to midpoint.
2. Turn the RESET control fully CCW to OFF.
3. Adjust the SETPOINT Control to the desired operating Setpoint.
4. Allow plenty of time for the controlled variable to stabilize at the operating Setpoint.
5. For either of the two conditions (a or b) that follow, after each change in setting of the GAIN control, a simulated process upset should be caused by changing the SETPOINT control about 5% (this is 50°F for a scale of 1000°F) of scale range. Such a simulated process upset will show any tendency to cycle. Changes in the setting of the SETPOINT control should be made up and down alternately to remain near the operating Setpoint selected in step 3.
   a. If the process variable is stable, turn the GAIN control CW in steps of one division until instability is reached. After the process becomes unstable, turn the GAIN control CCW one division.
   b. If the process variable is unstable and cycling occurs, turn the GAIN control one division CCW. Wait for the process to settle down. If still unstable, turn the GAIN control one division CCW again. Continue this procedure until the process settles down.
6. After the completion of step 5, allow time for the process to settle down. Then turn the RESET control to the midpoint position, and observe the behavior of the process.
   a. If the midpoint setting is the correct one, any proportional offset read on the temperature scale of the front panel meter at the end of step 5 will disappear in about 2 to 5 minutes, without overshoot.
   b. If the midpoint setting is too fast for the process, cycling will occur. If cycling occurs, turn the RESET control one division CCW. Wait for the process to settle down. If it does not, again turn the RESET control one division CCW. Continue this procedure until the process settles down.
7. Introduce a step change of 5 to 10%. For best results, the step response should be observed on a recorder. With a recording, very fine observations can be made to obtain closer to optimum settings.

   Taking a recording is almost mandatory for very critical processes, where both overshoots and settling times must be minimized. Fortunately, the majority of processes are not so critical and satisfactory results may be obtained without special equipment simply by observing the deviation.
   a. If more overshoot occurs than can be tolerated, decrease the setting of the GAIN control CCW in steps of about one division. If more than two steps are required, it may be preferable to turn the RESET control to a slower setting (turn CCW), rather than to continue on to an unusually wide Proportional Band (i.e., low GAIN control setting).
   b. If there is no overshoot, the time required to reach the new equilibrium may be excessive — at any rate, it can be reduced by increasing the GAIN control setting until a single, small overshoot occurs in response to a step change. Such a setting is usually preferred, as settling time is minimal. If more than three steps are required to obtain an overshoot, it may be preferable to advance the RESET control CW, then widen the Proportional Band (i.e., decrease the GAIN control setting CCW) to achieve stability.

1.3.5 MODEL 524B CONTROLLER WITH PROPORTIONAL PLUS INTEGRAL PLUS DERIVATIVE ACTION

First perform the procedure in paragraph 1.3.4.

Derivative time is continuously adjustable by the RATE control from 0 (fully CCW) to 3 (fully CW) minutes.

Derivative (Rate) action occurs only when the input signal is changing. Should too much Derivative action be added to a process, it will cause instability similar to the instability caused by too much Integral (Reset) action or too much Gain action. Too little Derivative action will not provide enough correction for error. With the correct amount of Derivative time applied, large upsets tend to be anticipated.

In general, a slow responding process requires very little if any Derivative time. The dial markings of the RATE control correspond to the time that the Proportional action is advanced — or the lead time that Proportional plus Derivative (Rate) action has over Proportional action alone.

1.3.6 CYCLE TIME

Cycle time is the time in seconds for one period of ON and OFF switching of the output load. A stopwatch is required to accurately set Cycle Time. Look at the Amber lamp and take an average of the time it is ON and OFF.

The CYCLE adjustment varies the switching rate from 6 (at CW) to 60 (at CCW) seconds per cycle. Faster cycle rates on the order of 6 seconds per cycle provide better control of loads with fast response times and little time lag. However, a relatively faster cycle time causes added wear on an external electromechanical contactor.

By removing capacitor C3 on the output board, Cycle Time can be changed to adjust from 0.6 to 6 seconds (nominal) for optimum control of a process with a Barber-Colman solid state contactor. Refer to Output Section 8 of this manual for location of this capacitor.

Barber-Colman Company
INDUSTRIAL INSTRUMENTS DIVISION

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LITHO IN U.S.A.

SERIES 520 — Models 521, 522, 523 and 524
Analog and Digital Setpoint Controllers

AMBER LAMP ON CONTROLLERS
Either glows to indicate Output 1's solid state switching is on,
or
Steady glow if Output 1 is a current output, to indicate power is on to the instrument.

RED LAMP ON LIMITROL
Steady glow indicates selected setpoint is exceeded.

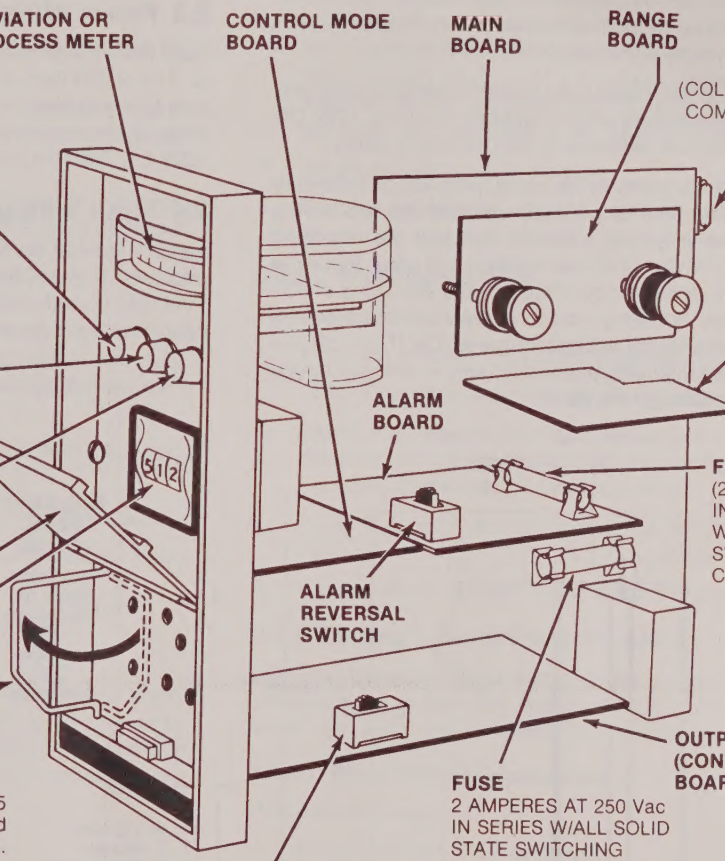
WHITE LAMP ON DUAL OUTPUT CONTROLLERS
Glows to indicate Output 2's solid state switching is on.

RESET PUSHBUTTON ON LIMITROL
Press to reset Limitrol after excess temperature drops below setpoint.

RED ALARM LAMP
Steady glow indicates an alarm.

DOOR SWUNG UP TO REVEAL CONTROL ADJUSTMENTS

DIGITAL SETPOINT HANDLE — Pull out to remove controller from its housing.


DEVIATION OR PROCESS METER
CONTROL MODE BOARD
MAIN BOARD
RANGE BOARD
BALCO (COLD JUNCTION COMPENSATION)
ISOLATION BOARD
ALARM BOARD
FUSE (2A at 250 Vac) IN SERIES WITH ALARM SWITCHING CONTACTS
ALARM REVERSAL SWITCH
OUTPUT (CONTROL FORM) BOARD
FUSE 2 AMPERES AT 250 Vac IN SERIES W/ALL SOLID STATE SWITCHING OUTPUTS
20 AMPERES AT 250 Vac IN SERIES WITH LIMITROL CONTACTS
OUTPUT 2 REVERSING SWITCH FOR ON-OFF OUTPUTS ONLY

NOTE: When either Setpoint Option 2 or 5 is specified, the red alarm lamp is replaced by the two position LOCAL-REMOTE switch. In the REMOTE position (down) the setpoint is an external setpoint on rear panel terminals 4 and 5. In the LOCAL position (up) the setpoint is determined by the setpoint control below the switch.

When Setpoint Option 7 is specified, the Setpoint is omitted.

When Setpoint Option 8 is specified, the Setpoint is replaced by a Trim Control which can be set to adjust the setpoint signal from a Master Controller ±5% of span.

WARNING
FUSE SIZE MUST NOT BE EXCEEDED. COPPER FOIL ON MAIN BOARD WILL BE DESTROYED AT HIGHER CURRENTS.

Figure 2-1. Parts Description

GAIN
Proportional Action Only: 10 to 100 (P.B.: 10 to 1%)
Proportional plus Integral Action: 1 to 100 (P.B.: 100 to 1%)
Derivative (Rate) Action does not affect the gain or P.B.

RATE (DERIVATIVE TIME)
0 to 3 Minutes

MANUAL RESET
0 to 100% output at null

AUTOMATIC RESET
.06 to 6 repeats per minute. CCW click off.

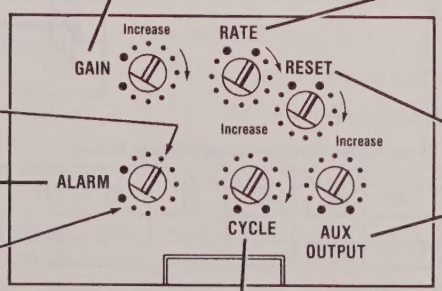
DEVIATION ALARM
Up to ±25% of span from setpoint

DEVIATION BAND ALARM
Adjustable from 3% to 50% of span centered about setpoint

PROCESS ALARM
0–100% of span

End opposite flat is the set position

Controls have flatted shafts



COOLING LIMIT ADJUSTMENT (located in the hole marked AUX OUTPUT). Continuously adjustable to limit the percent ON time between 5 (CCW) and 100 (CW). This prevents excess cooling. Only on models 522H, 523H, 524H, 522J, 523J, 524J, 522K, 523K, and 524K.

6 to 60 sec. B, E

10 to 30 sec. H, J, K

Determines separation of Output 1 and Output 2 on Dual Output Controllers from −25% to +25% of span from the setpoint selected on the Output 1 setpoint.

Output 2 is switch reversible. Only on models 522E, 523E, 524E, 522F, 523F, 524F, 522G, 523G, and 524G.

Figure 2-2. Functions of Internal Front Panel Controls

2.1 After Unpacking

Check the contents of the shipping container against the packing slip. If the equipment is damaged in transit, report the extent of the damage to the carrier immediately.

2.2 Mounting

The Series 520 can be mounted in any position. The instrument is rated for an ambient temperature from 5° to 55°C (40° to 130°F), and relative humidity from 0 to 70% RH.

Refer to Figure 2-3 for Panel Cutout and Mounting Dimensions. Dimensions guaranteed only if Certified Drawing, 1252 DR 4-1, is used. Consult factory to order Certified Drawing.

After the cutout is made in the panel, proceed as follows to install one instrument. Completely unscrew the two driving screws for the mounting brackets and pull the mounting brackets completely out of their tracks in the case. Place the housing in the panel cut-out. Replace the mounting brackets. Tighten the mounting bracket screws until the brackets hold the housing snugly against the panel. CAUTION: Do not over-tighten the mounting bracket screws — over-tightening screws could damage the panel.

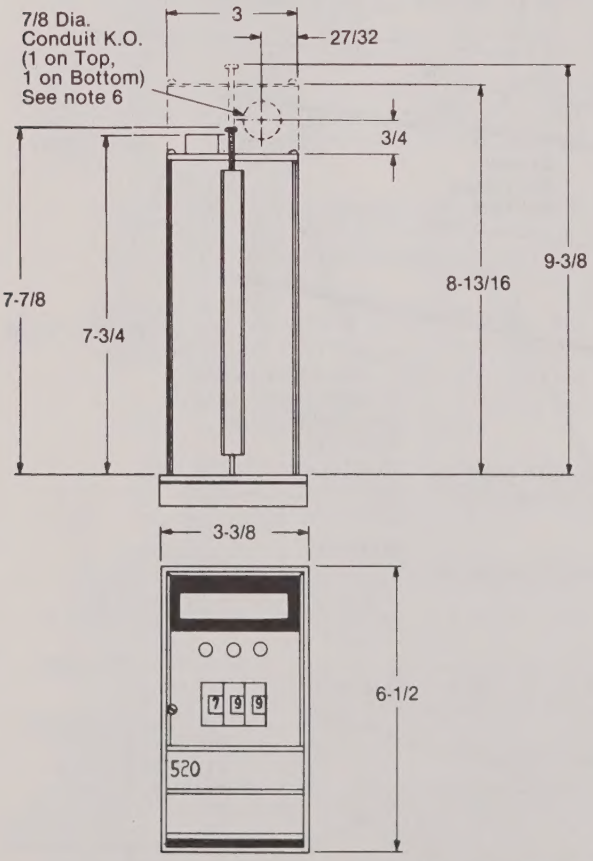
The captive screw on the left side of the panel in the middle is the fastener for the instrument. After the housing is mounted in the panel, push the controller firmly into its slot until the screw touches the threaded hole in back of it. Do not push instrument further but instead turn screw clockwise until instrument is pulled fully into its housing.

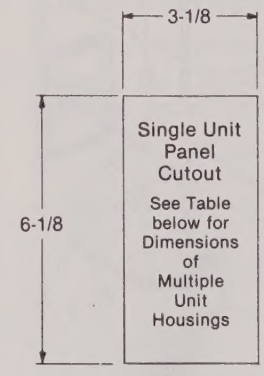
2.3 Power Wiring

Input line voltage must be 120 or 240 Vac, ±10%, at 60 Hz; or, 110 or 220 Vac, ±10%, at 50 Hz; by rear terminal selection. Connect the line voltage to the terminal marked L2 and either the terminal marked 240V L1 or the terminal marked 120V L1. Connect panel ground to the GROUND terminal.

2.4 Input Wiring

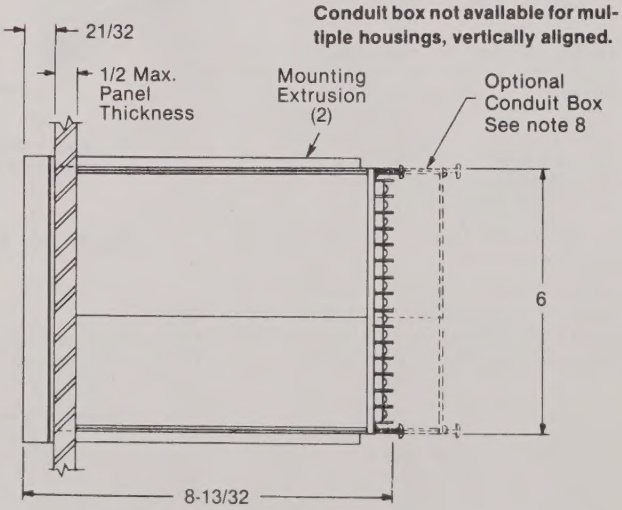
Install a quality Barber-Colman thermocouple for your application. Barber-Colman thermocouple catalogs, such as 1111/DB 12 and 1130/DB 1, list a complete line of thermocouple assemblies and thermocouple extension leadwire.





NOTES:

1. All dimensions in inches.
2. Tolerance all dimensions ±1/16.
3. Dimensions guaranteed only if this print is certified. Consult factory.
4. Min. horz. spacing centers 3-7/16.
5. Min. vert. spacing centers 6-9/16.
6. Appleton No. 92T050 two piece steel conduit connector or equivalent must be used for conduit connections.
7. For mounting in a 19″ relay rack 7″ high the max. no. of units will be 1 row of 5.
8. Conduit box fitted to case at factory. **Conduit box not available for multiple housings, vertically aligned.**



Number of Units Aligned Horizontally and Width in Inches

No. of Units Vertically Aligned	Height of Cutout in Inches	1	2	3	4	5	6	7	8	9
1	6-1/8	3-1/8	6-9/16	10	13-7/16	16-7/8	20-5/16	23-3/4	27-3/16	30-5/8
2	12-11/16	3-1/8	6-9/16	10	13-7/16	16-7/8	20-5/16	23-3/4	27-3/16	30-5/8

All Dimensions in Inches

Total Number of Units = Units Horizontal × Units Vertical

Examples:

1. Single Panelmount cutout is 3-1/8″ wide by 6-1/8″ high.
2. An array of 9 wide by 2 high, cutout is 30-5/8″ wide by 12-11/16″ high.
3. For one row of 5 housings, cutout is 16-7/8″ wide by 6-1/8″ high.

Note: Standard Relay Rack Panel Cutouts are made at the factory; and, the housings specified are shipped fastened to the panel. **See 1252/DB 3 for more information on Multiple Unit Housings.**

Figure 2-3. Mounting Dimensions

The SIGNAL input terminals are marked TC + and TC − and are for any input.

Thermocouples should never be wired using ordinary copper wire. Use only thermocouple extension leadwire.

Observe the correct thermocouple and thermocouple extension wire polarity. The NEGATIVE (−) wire is usually coded RED.

Do not place power wiring and thermocouple wiring in the same conduit or wiring trough.

If shielded thermocouple leads are used, shields should be insulated electrically and terminated at one location, preferably the instrument chassis.

For RTD sensors there is no polarity to observe. For three wire RTD sensors, connect the two WHITE wires together.

2.5 Alarms

2.5.1 General

These alarms are not recommended for safety purposes. For safety purposes the Models 521L and 521T Limitrols are recommended.

Alarm boards in the Series 520 are shipped from the factory with the following wiring conditions:

1. Alarm light is on when alarm relay is de-energized.
2. Normally open alarm contact is connected to instrument alarm terminals.

2.5.2 ALARM Potentiometer and Alarm Reversal Switch

Either a Process, a Deviation, or a Deviation Band Alarm may have been specified. The alarm action is determined by the front panel ALARM pot and by a slideswitch located on the Alarm Board. Figure 2-1 shows the location of the switch.

Set the switch as follows.

Process Alarm: pull out to alarm* on decreasing signal, push in to alarm* on increasing signal.

Deviation Alarm: pull out to alarm* on decreasing signal, push in to alarm* on increasing signal.

Deviation Band Alarm: push in to alarm* inside the bandwidth, pull out to alarm* outside the bandwidth,

*"to alarm" means that terminals 6 and 7 open.

Next, set the ALARM potentiometer.

The Process Alarm can be set to trip anywhere within the span of the instrument (0 to 100% of span) by means of the 20-turn ALARM potentiometer. Turn the ALARM pot clockwise to increase the alarm trip point.

The Deviation Alarm can be set to trip up to ± 25% of span from setpoint by means of the single turn ALARM potentiometer. With the ALARM pot turned fully CCW the alarm will trip at a deviation of 25% of span below setpoint.

With the ALARM pot fully CW the alarm will trip at a deviation of 25% of span above the setpoint.

The Deviation Band Alarm can be set to trip from plus and minus 1.5% of span about setpoint to plus and minus 25% of span about setpoint. Total bandwidth is adjustable from 3% to 50% of span centered about setpoint. Rotating the single-turn ALARM pot clockwise (CW) widens the deviation band.

2.5.3 Setting a Deviation Alarm Trip Point

2.5.3.1 With Millivolt Source Input

Proceed as follows.

1. Disconnect any input or output.
2. Turn power on to the Series 520.
3. Connect a d-c millivolt source (B-C Portable Potentiometer output) to the SIGNAL input terminals. Increase the millivolt input signal until it is above (below for a low deviation alarm) midscale and the difference between the signal and midscale is the desired deviation.
4. Adjust the setpoint to midscale.
5. Turn the ALARM potentiometer until the red alarm lamp lights.

2.5.3.2 With Process Input

Proceed as follows.

1. Allow the process to stabilize at the desired setpoint.
2. Quickly perform steps 3, 4 and 5 that follow.
3. Adjust the setpoint until it is below (above for a low deviation alarm) the desired setpoint mentioned in step 1, by the amount of the alarm deviation.
4. Turn the ALARM potentiometer until the red alarm lamp lights.
5. Quickly return setpoint to the value it had in step 1.

2.5.4 Setting a Deviation Band Alarm

With the Deviation Band Alarm option, when the ALARM potentiometer is fully CW, the bandwidth is 50% of span. When fully CCW, the bandwidth is about 3% of span.

2.5.4.1 With Millivolt Source Input

Proceed as follows.

1. Disconnect any input or output.
2. Turn power on to the Series 520.
3. Connect a d-c millivolt source (B-C Portable Potentiometer output) to the SIGNAL input terminals. Increase the millivolt input signal until it is above (or below) midscale and the difference between the signal and midscale is half the desired bandwidth.
4. Adjust the setpoint to midscale.
5. Turn ALARM potentiometer until red lamp lights.

2.5.4.2 With Process Input

Proceed as follows.

1. Allow the process to stabilize at the desired setpoint.
2. Quickly perform steps 3, 4 and 5 that follow.
3. Adjust the setpoint until it is above (or below) the desired setpoint mentioned in step 1, by the amount of half the bandwidth.
4. Turn the ALARM potentiometer until the red alarm lamp lights.
5. Quickly return setpoint to the value it had in step 1.

2.5.5 Setting a Process Alarm Trip Point

Proceed as follows.

1. Disconnect any input or output.
2. Turn power on to the Series 520.
3. Connect a d-c millivolt source to the SIGNAL input terminals. Adjust the millivolt input signal to the equivalent of the desired alarm temperature.
4. Turn the ALARM potentiometer until the red alarm lamp lights.

2.5.6 Re-connecting the Red Alarm Lamp to Indicate a Safe Condition

Do not make this wiring change for a safety related application. This wiring condition is suitable for such purposes as the following: indicating that temperature is normal, furnace or extruder is ready to operate, extruder barrel temperature is at required temperature, zone temperature on furnace or extruder is at required temperature.

To make this wiring change refer to Figure 2-4 and proceed as follows. A black lead from the red alarm lamp is connected to terminal D on the Alarm Board. Disconnect the black lead from terminal D and connect it to the adjacent terminal E.

2.5.7 Re-connecting the Normally Open Alarm to Normally Closed

Do not make this wiring change for a safety related application. This wiring condition is suitable for such purposes as the following: programming and sequencing.

To make this wiring change refer to Figure 2-4 and proceed as follows. A gray wire from the printed circuit board connector number 11 is connected to terminal B. Disconnect the gray wire from terminal B and connect it to terminal A.

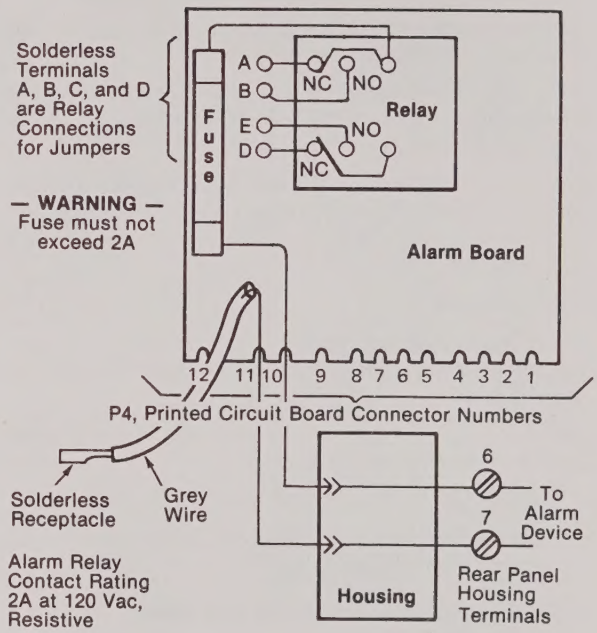


Figure 2-4. Alarm Wiring

2.6 Reversing the ON-OFF Output — Model 521A

— IMPORTANT —

INSTRUMENT MUST HAVE BEEN ORDERED WITH DOWNSCALE TCB (THERMOCOUPLE BREAK ACTION) IN ORDER TO MAKE THIS CHANGE.

The Model 521A is shipped with pin A connected to pin B by means of a jumper; and, with pin C connected to pin D by means of a jumper.

To reverse the ON-OFF output, make the jumper connections shown in Figure 2-5; that is, connect pin C to pin B, and connect pin A to pin D.

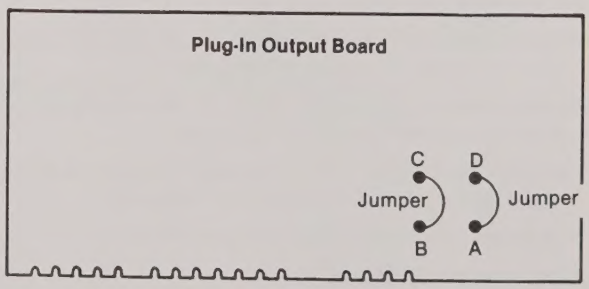


Figure 2-5. Jumpers

2.7 Changing Limitrol Output from High Limit to Low Limit — Models 521L and 521T

— IMPORTANT —

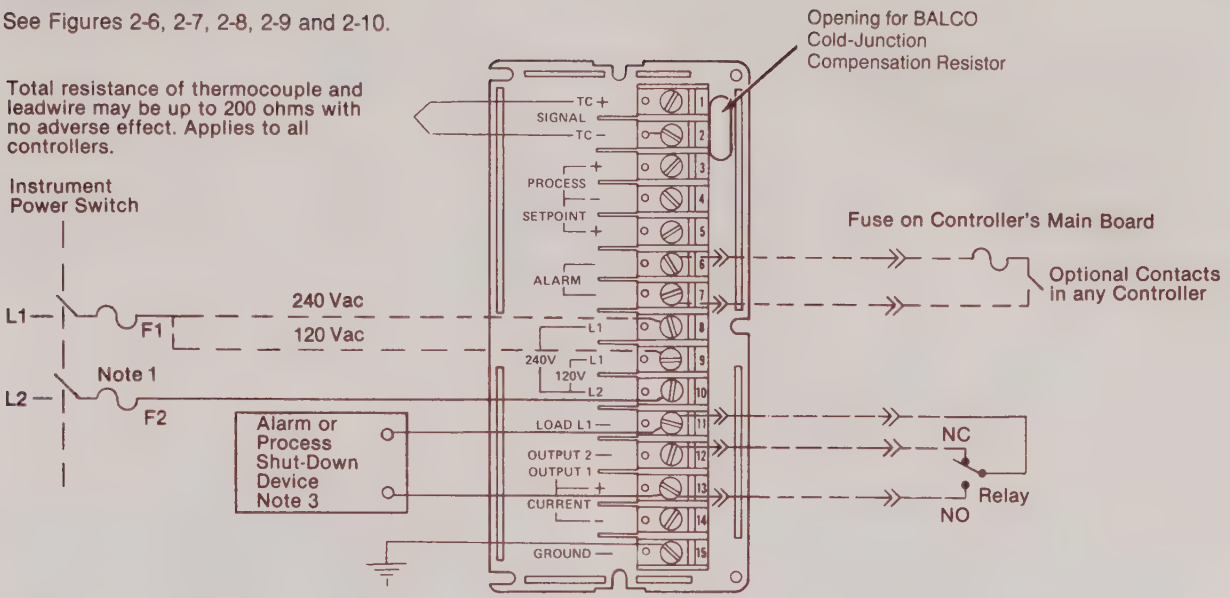
INSTRUMENT MUST HAVE BEEN ORDERED WITH DOWNSCALE TCB (THERMOCOUPLE BREAK ACTION) IN ORDER TO MAKE THIS CHANGE.

The Model 521L is shipped with pin A connected to pin B by means of a jumper; and, with pin C connected to pin D by means of a jumper. This is an "upscale" Limitrol.

To change to a "downscale" Limitrol make the jumper connections shown in Figure 2-5; that is, connect pin C to pin B, and connect pin A to pin D.

2.8 Output Wiring

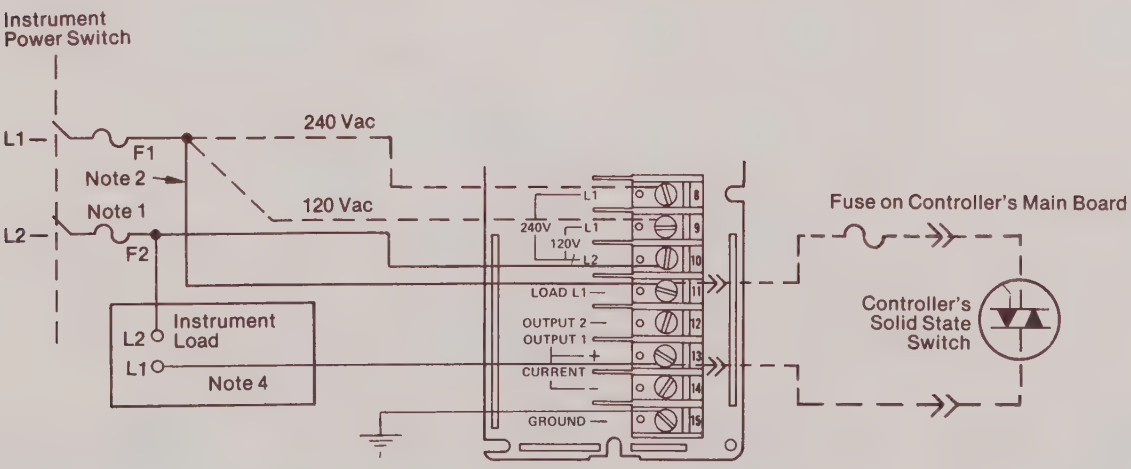
See Figures 2-6, 2-7, 2-8, 2-9 and 2-10.



Notes:

1. Instrument power switch and instrument fuses are included for illustrative purposes only. If the L2 line is a neutral or ground line, fuse F2 is not normally recommended. Consult local codes and appropriate wiring standards.
2. Limitrol Relay Contact Ratings: 5A at 120 or 240 Vac.
3. Power connections are made at the discretion of the installer.

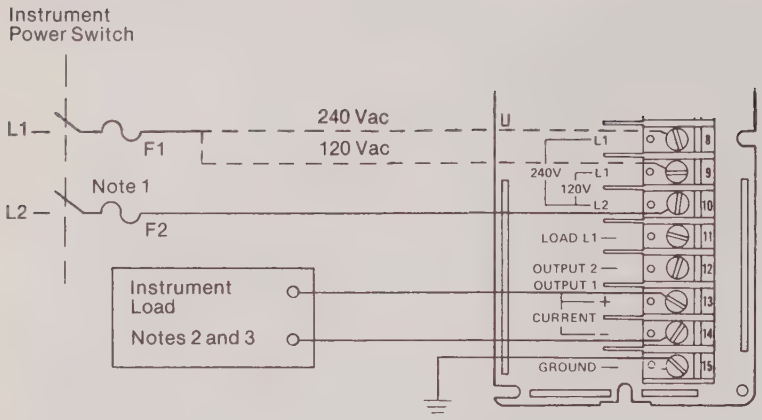
Figure 2-6. Output Wiring, Limitrol Models 521L and 521T



Notes:

1. Instrument power switch and instrument fuses are included for illustrative purposes only. If the L2 line is a neutral or ground line, fuse F2 is not normally recommended. Consult local codes and appropriate wiring standards.
2. Instrument load power, LOAD L1, may be obtained from a separate power source in phase with the instrument power supply. Instrument signal light will not operate unless instrument L2 and instrument load L2 are connected as shown. Instrument signal light will not operate if LOAD L1 is powered by a separate source of less than 100 Vac rms.
3. Instrument load may be either a contactor coil, a Barber-Colman SOLID STATE CONTACTOR, or heater.
4. Rating of Solid State Switching Output: (both ON-OFF and Time-Proportioning): 1A continuous, 10A inrush, 50mA minimum. Any voltage from 24 Vac to 240 Vac can be switched but the voltage switched must be the same phase and have the same common line as the instrument power supply.

Figure 2-7. Output Wiring, Single Solid State Switching Output Models 521A and 522B, 523B, 524B

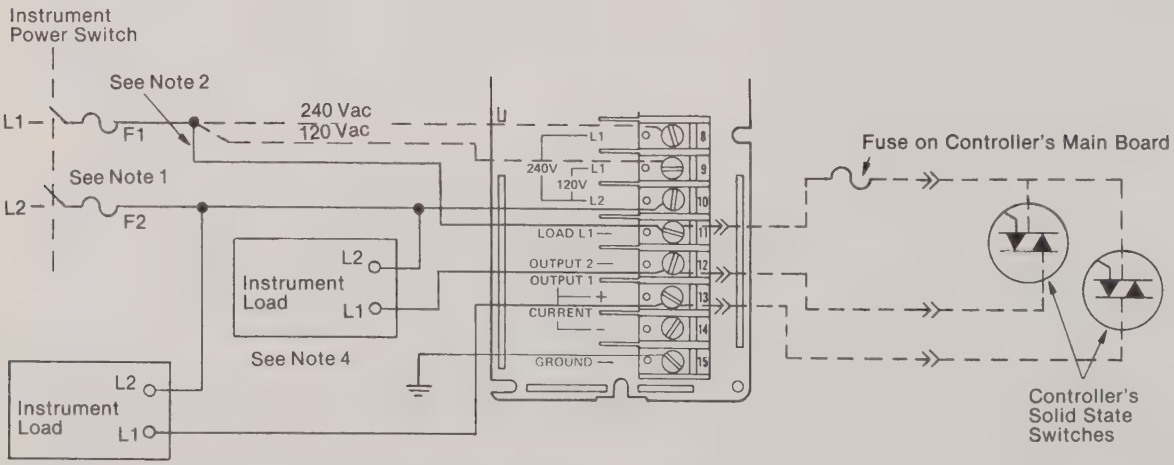


Notes:

1. Instrument power switch and instrument fuses are included for illustrative purposes only. If the L2 line is a neutral or ground line, fuse F2 is not normally recommended. Consult local codes and appropriate wiring standards.
2. The constant current outputs of these controllers are short circuit proof. Either plus or minus may be grounded or remain floating.
3. Either the 2–12mA or 4–20mA output will drive the Model 658 Current-to-Position Converter for positioning a Barber-Colman Motor Operator or a Current-to-Pneumatic Transducer.

   Either current output will drive Barber-Colman Power Controllers.
4. Current Output: either 2–12mA into 1.5k ohms or less; or 4–20mA into 750 ohms or less.

Figure 2-8. Output Wiring, Single Current Output Models, 522C, 523C, 524C and 522D, 523D, 524D 522P, 523P, 524P and 522Q, 523Q, 524Q



Notes:

1. Instrument power switch and instrument fuses are included for illustrative purposes only. If the L2 line is a neutral or ground line, fuse F2 is not normally recommended. Consult local codes and appropriate wiring standards.
2. Instrument load power, LOAD L1, may be obtained from a separate power source in phase with the instrument power supply. Instrument signal light will not operate unless instrument L2 and instrument load L2 are connected as shown. Instrument signal light will not operate if LOAD L1 is powered by a separate source of less than 100 Vac rms.
3. Instrument load may be either a contactor coil, a Barber-Colman SOLID STATE CONTACTOR, or heater.
4. Rating of Solid State Switching Output: (both ON-OFF and Time-Proportioning): 1A continuous, 10A inrush, 50mA minimum. Any voltage from 24 Vac to 240 Vac can be switched but the voltage switched must be the same phase and have the same common line as the instrument power supply.

Figure 2-9. Output Wiring, Dual Solid State Switching Outputs. Models 522E, 523E, 524E and 522H, 523H, 524H

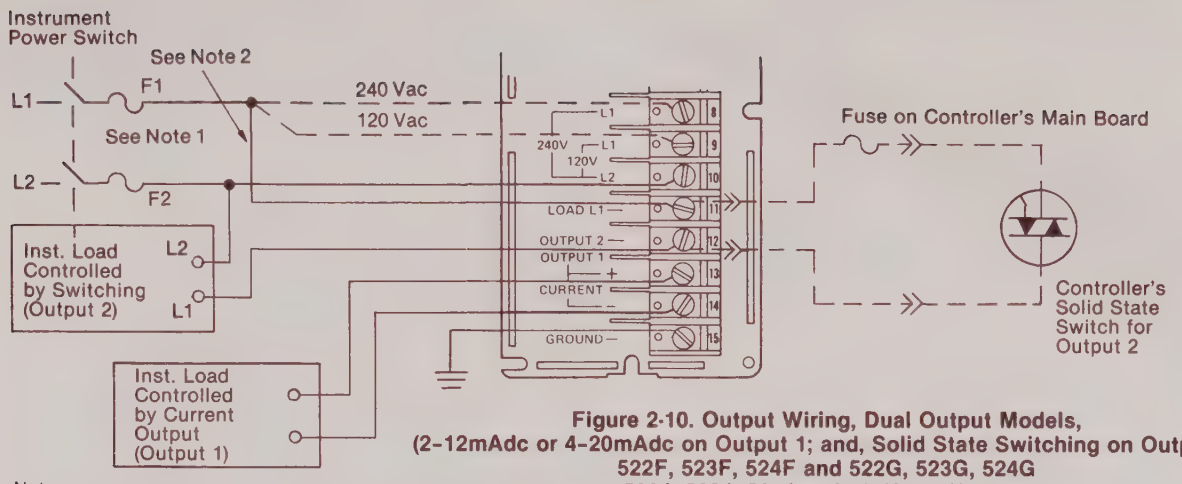


Figure 2-10. Output Wiring, Dual Output Models, (2-12mAdc or 4-20mAdc on Output 1; and, Solid State Switching on Output 2) 522F, 523F, 524F and 522G, 523G, 524G 522J, 523J, 524J and 522K, 523K, 524K

Notes:

1. Instrument power switch and instrument fuses are included for illustrative purposes only. If the L2 line is a neutral or ground line, fuse F2 is not normally recommended. Consult local codes and appropriate wiring standards.
2. OUTPUT 1: The constant current outputs of these controllers are short circuit proof. Either plus or minus may be grounded or remain floating.

   Either the 2–12mA or 4–20mA output will drive the Model 658 Current-to-Position Converter for positioning a Barber-Colman Motor Operator or a Current-to-Pneumatic Transducer.

   Either current output will drive Barber-Colman Power Controllers.

   Current Output: either 2–12mA into 1.5k ohms or less; or 4–20mA into 750 ohms or less.
3. OUTPUT 2: Instrument load power, LOAD L1, may be obtained from a separate power source in phase with the instrument power supply. Instrument signal light will not operate unless instrument L2 and instrument load L2 are connected as shown. Instrument signal light will not operate if LOAD L1 is powered by a separate source of less than 100 Vac rms.

   Instrument load may be either a contactor coil, a Barber-Colman SOLID STATE CONTACTOR, or heater.

   Rating of Solid State Switching Output: (both ON-OFF and Time-Proportioning): 1A continuous, 10A inrush, 50mA minimum. Any voltage from 24 Vac to 240 Vac can be switched but the voltage switched must be the same phase and have the same common line as the instrument power supply.

2.9 Setpoint Wiring — Isolated

2.9.1 Input Setpoint Wiring (Setpoint Options 2, 5, 7 and 8)

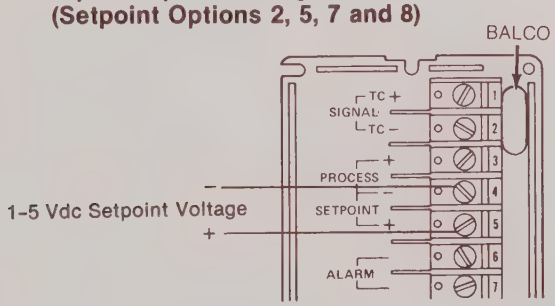


Figure 2-11. Setpoint Wiring

Notes:

1. **Options 2 or 5:** Setpoint with Remote-Local Switch.

   Source should be free of transients and have an impedance less than 200 ohms. For operation of more than one controller from the same external source, a source resistance under 50 ohms is recommended. Typical input impedance of 1 meg ohm.

   A REMOTE-LOCAL switch on the front panel allows the setpoint source to be either the front panel setpoint or the remote setpoint. For start-up or servicing the instrument may be switched to local setpoint operation. After start-up or servicing, control is returned to the remote setpoint.
2. **Option 7:** No Setpoint, requires remote setpoint voltage.

   Source should be free of transients and have an impedance less than 200 ohms. For operation of more than one controller from the same external source, a source resistance under 50 ohms is recommended.
3. **Option 8:** Trim Setpoint

   Requires 1–5 Vdc Setpoint Voltage from an external source. Source resistance up to 20 ohms.

   The Trim Control, located in place of the Digital Setpoint, adjusts the remote 1–5 Vdc input setpoint signal ±5% of span. Typical input impedance is 20k ohms.

   The input setpoint signal is usually trimmed to either correct for sensor difference or to select a desired temperature profile.

2.9.2 Output Setpoint Wiring (Setpoint Options 3 or 6)

1–5 Vdc proportional to instrument setpoint span. Short circuit has no effect on control action. Source resistance less than 10 ohms.

The Series 520 operates as a Master Controller which can transmit a 1–5 Vdc output setpoint voltage to many multiple Slave Controllers.

Maximum total output current of Process Signal Output option plus Output Setpoint Voltage option is 10 mAdc.

2.10 Process Signal Wiring — Isolated

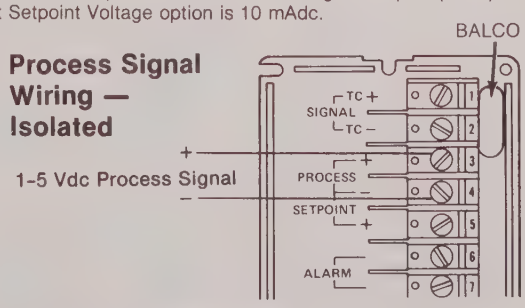


Figure 2-12. Process Signal Output Wiring (Setpoint Options 2, 3, 5, 6, 7 and 8)

External short circuit has no effect on control action. Source resistance less than 10 ohms.

Setpoint options 2, 3, 5, 6, 7 and 8 include Interface Signal Isolation. This means that the Process Signal and Setpoint Signal Outputs are isolated from the signal input terminals. There is also Input-Output Isolation.

Model number located under access door. Specify complete 15-digit model number on any inquiry to Barber-Colman Company.

52□□ - □ □□□□ - □□□ - □ - □□

Series

Control Mode
1 — ON-OFF or Limitrol (only with A, L or T below)
2 — Proportional Controller
3 — Proportional + Integral (Reset)
4 — Proportional + Integral + Derivative (Rate)

Output Control Form
A — ON-OFF (only with 1 above)
B — Time Proportioning
C — Current: 2-12 mA, Reverse Acting
D — Current: 4-20 mA, Reverse Acting
E — Dual—Time Proportioning and on-off auxiliary output
F — Dual—Current 2-12 mA and on-off auxiliary output
G — Dual—Current 4-20 mA and on-off auxiliary output
H — Dual—Time Proportioning on both outputs
J — Dual—Current 2-12 mA and Time Proportioning auxiliary output
K — Dual—Current 4-20 mA and Time Proportioning auxiliary output
L — Limitrol (only with 1 above)
P — Current: 2-12 mA, Direct Acting
Q — Current: 4-20 mA, Direct Acting
T — Limitrol (only with 1 above)

Setpoint
1 — Analog Setpoint
2 — Analog Setpoint with Remote-Local Switch
3 — Analog Setpoint with output setpoint voltage available
4 — Digital Setpoint (standard)
5 — Digital Setpoint with Remote-Local Switch
6 — Digital Setpoint with output setpoint voltage available
7 — None. Requires remote setpoint voltage
8 — Trim Setpoint. Requires remote setpoint voltage
9 — Other

Setpoint options **2, 3, 5, 6, 7** and **8** include a Process Signal Output

Range Code
Four Digit Range Code

Input Signal
0 — Thermocouple Upscale TCB
1 — Thermocouple Downscale TCB
2 — Resistance Bulb
4 — Vdc (above 0.1 Vdc)
5 — mAdc
6 — Radiation Pyrometer Emissivity Correction
8 — mVdc (below 100 mVdc)
9 — Other

Readouts
1 — Deviation Meter (standard)
3 — Process Meter
5 — Digital Process Meter
7 — Deviation Meter with 1.8 inch Scale

Housing
0 — Panelmount (standard)
1 — Shipped without housing—order housing separately
2 — Panelmount with conduit openings and rear cover

Specify **1** above and see 1252 DB 3 to order high density housings for either Panel or Standard Relay Rack Mounting.

Alarms
0 — None (standard)
1 — Deviation Alarm
2 — Deviation Band Alarm
3 — Process Alarm

Specials
00 — None. Consult factory for all Specials

All of the models include, as standard, indicator lights appropriate to the output form selected.

CALIBRATION CHARTS, DIGITAL SETPOINT ONLY

0 TO 799°F/J
DIGITAL RANGE CODE 0016

True Temp °F	Dial Setting or DPM Reading	Setpoint Voltage	Input mV
0	12	1.059	-0.89
50	57	1.286	0.51
100	104	1.520	1.94
150	152	1.759	3.41
200	200	2.003	4.91
250	250	2.250	6.42
300	299	2.499	7.95
350	349	2.749	9.48
400	400	3.000	11.02
450	450	3.252	12.57
500	500	3.503	14.11
550	550	3.754	15.65
600	600	4.005	17.19
650	650	4.255	18.72
700	700	4.505	20.25
750	750	4.755	21.78
799	799	5.000	23.29

0 TO 598°F/J
DIGITAL RANGE CODE 0015

True Temp °F	Dial Setting or DPM Reading	Setpoint Voltage	Input mV
0	10	1.069	-0.89
25	33	1.219	-0.20
50	56	1.373	0.51
75	79	1.528	1.22
100	103	1.686	1.94
125	127	1.846	2.67
150	151	2.007	3.41
175	175	2.170	4.16
200	200	2.333	4.91
225	224	2.498	5.66
250	249	2.664	6.42
275	274	2.830	7.18
300	299	2.997	7.95
325	324	3.165	8.71
350	349	3.333	9.48
375	375	3.501	10.25
400	400	3.669	11.02
425	425	3.838	11.79
450	450	4.006	12.57
475	475	4.175	13.34
500	501	4.343	14.11
525	526	4.511	14.88
550	551	4.679	15.65
575	576	4.847	16.42
598	599	5.000	17.12

200 TO 1190°F/J
DIGITAL RANGE CODE 0203

True Temp °F	Dial Setting or DPM Reading	Setpoint Voltage	Input mV
200	202	1.010	4.91
250	251	1.206	6.42
300	301	1.404	7.95
350	351	1.603	9.48
400	401	1.803	11.02
450	451	2.003	12.57
500	501	2.203	14.11
550	550	2.403	15.65
600	600	2.603	17.19
650	650	2.802	18.72
700	700	3.000	20.25
750	749	3.199	21.78
800	799	3.398	23.32
850	849	3.597	24.85
900	899	3.797	26.40
950	949	3.999	27.95
1000	1000	4.202	29.52
1050	1051	4.407	31.10
1100	1103	4.616	32.71
1150	1156	4.827	34.34
1190	1199	5.000	35.67

0 TO 1999°F/K
DIGITAL RANGE CODE 0030

True Temp °F	Dial Setting or DPM Reading	Setpoint Voltage	Input mV
0	13	1.027	-0.69
100	109	1.217	1.52
200	208	1.415	3.82
300	305	1.611	6.09
400	401	1.803	8.31
500	498	1.996	10.56
600	597	2.194	12.85
700	697	2.394	15.18
800	798	2.596	17.52
900	899	2.800	19.88
1000	1001	3.004	22.25
1100	1103	3.208	24.62
1200	1205	3.411	26.98
1300	1305	3.612	29.31
1400	1405	3.812	31.63
1500	1504	4.009	33.91
1600	1601	4.203	36.17
1700	1696	4.394	38.39
1800	1790	4.583	40.58
1900	1883	4.768	42.73
1999	1974	4.950	44.83

Barber-Colman Company
INDUSTRIAL INSTRUMENTS DIVISION
1700 Rock Street, Rockford, Illinois, U.S.A., 61101

October, 1980

LITHO IN U.S.A.

MODELS 521, 522, 523 AND 524
MAIN BOARD CIRCUITS, AND CALIBRATION
(Includes Wiring Diagram and Replaceable Mechanical Parts)

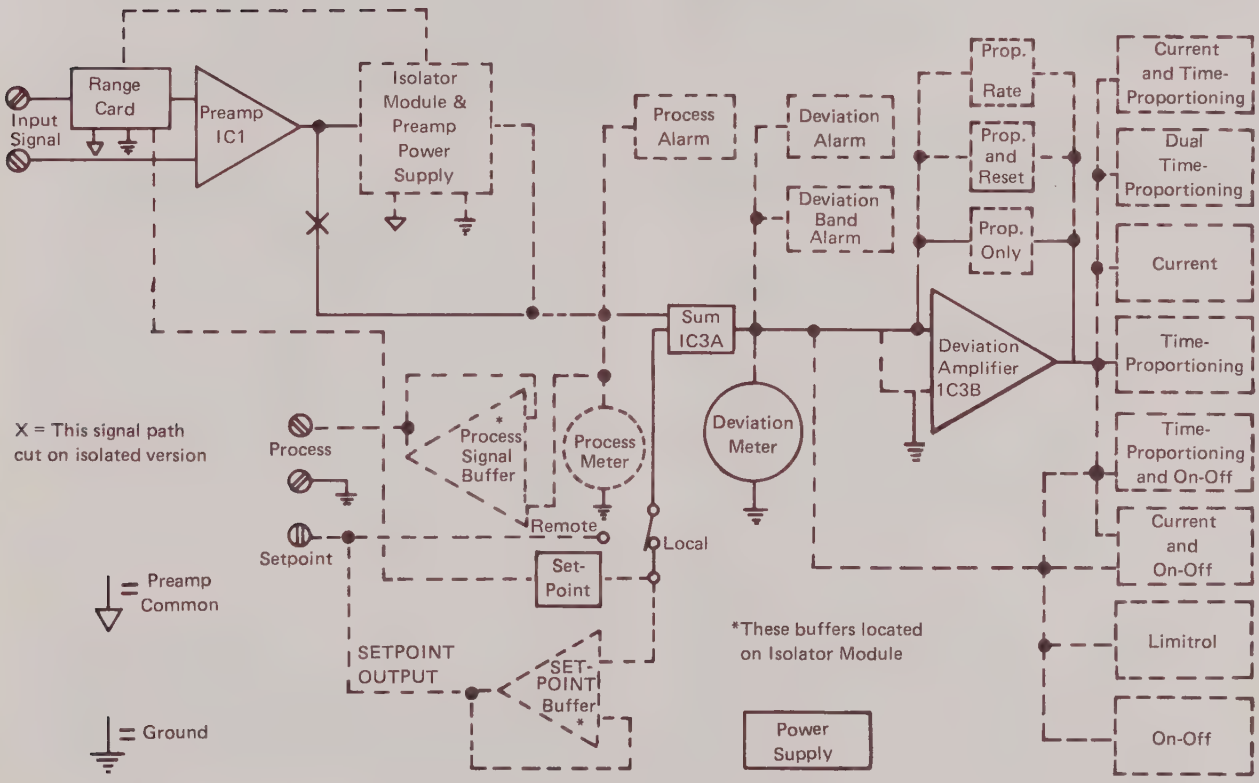


Figure 3-1. Simplified Block Diagram.

3. INTRODUCTION

3.1 General Description

Descriptions common to all models of the Series 520 are included in this section. Figures showing replaceable mechanical parts and a wiring diagram for all models are at the end of the section.

3.2 Main Board

3.2.1 OVERALL DESCRIPTION

See Figure 3-1. For a thermocouple input, the signal to the Preamplifier is the thermocouple signal minus the cold junction reference signal. The Preamplifier amplifies the direct current millivolt input signal to drive an optional process meter and an optional alarm board. When the temperature of the input thermocouple and the temperature set on the front panel setpoint are the same, the output (error signal) of the SUM network on the Main Board is zero. At zero error signal, the input to the deviation meter will be zero, and it will indicate zero deviation. Any signal other than zero is amplified by the Deviation Amplifier. Gain plus Manual Reset or Gain plus Integral plus Derivative action takes place on a separate board. The Demand Signal from the Deviation Amplifier drives the output control board. ON-OFF Control Forms such as the 520L, T, and A and Output 2 of the E, F, and G receive a driving signal directly from the Sum Amplifier output (deviation signal).

3.2.2 CIRCUIT DESCRIPTION

See Schematic Figure 3-3.

3.2.2.1 Preamplifier IC1

The gain is fixed by resistors R6 and R7 on the Range Board. The output of IC1 on pin 10 which ranges from 2 to 10 Vdc is the amplified process signal. This process signal drives the front panel process meter, and also appears on rear panel terminals 3 and 4.

R8 and R9 on the Isolator Board divides the 2 to 10 Vdc down to 1 to 5 Vdc. IC2B is a buffer stage that prevents instrument control from being affected if terminals 3 and 4 are shorted.

3.2.2.2 IC3A Sum

IC3A on the Main Board sums the process signal with the setpoint signal. The output of IC3A on pin 1 is the deviation signal.

3.2.2.3 Current Source IC4 for the Setpoint Voltage

The voltage reference source for the current source is resistor divider R20, R21 and trimpot R22. The 5 Vdc reference voltage is connected across the digital setpoint resistance and R9 on the Range Board. Changing the numerical value of the digits on the setpoint changes the resistance in the emitter leg of Q2 and generates the 1–5 Vdc setpoint signal in the collector of Q2.

3.2.2.4 Op Amp IC3B

IC3B is the deviation amplifier for amplifying the deviation signal to supply a demand signal. The gain adjustment is R23. When manual reset is furnished with the Proportional only Control Mode, the manual reset voltage is summed with the deviation signal on pin 5 of IC3B. The demand signal output on pin 7 of IC3A drives the output control form board. The amplifier also sums the correction signal from either the PI or PID boards.

3.2.2.5 Power Supplies +15 Vdc, -15 Vdc & -30 Vdc

The -30 Vdc supply has only its transformer on the Main Board. The remainder of its circuit is on any output control form board with a current output. The ac voltage from the transformer is on pins 10 and 11 of P5. The +15 Vdc potential is established by IC2 which is an integrated circuit regulator. The +15 Vdc voltage is adjusted by R18. Zener diode D5 and series pass transistor Q1 provides the regulation for the -15 Vdc supply.

3.2.2.6 Setpoint Options 1 and 4: – Setpoint Only

This is the internal setpoint only. Option 4 is standard.

3.2.2.7 Setpoint Options 2 and 5: – Setpoint With Remote Local Switch

This simple circuit switches between remote and internal terminals. The 1–5 Vdc remote setpoint signal is filtered by R30 and C14 and then summed with the process signal from IC1A on the Isolation Board.

3.2.2.8 Setpoint Options 3 and 6: – Setpoint With Output Setpoint Voltage Available

IC3 on Isolation Board is a buffer with a low output impedance. IC3 prevents loss of control action should rear panel terminals 4 and 5 be shorted.

3.2.2.9 Setpoint Option 7: – No Built-in Setpoint, Accepts Remote Setpoint Voltage

The 1–5 Vdc remote setpoint signal is filtered by R30 and C14, and then summed with the process signal from IC1A of Isolation Board.

3.2.2.10 Setpoint Option 8: – Trim Setpoint. Requires Remote Setpoint Voltage

See Figure 3-4.
This option is on board A-10278 located on the rear of the front panel mounted Trim Control. The Trim Control replaces the standard digital setpoint. The 1–5 Vdc remote setpoint signal is summed with a trim setpoint voltage, which is at a potential of ±5% of setpoint span. This "new" setpoint voltage is then summed with the process signal from IC1A.

3.2.3 CALIBRATION

3.2.3.1 General

All adjustments are factory set and normally do not require readjustment. Verification of instrument accuracy within specifications, or determination if recalibration is necessary, can be determined by performing the calibration check procedures.

3.2.3.2 Calibration Equipment

The following equipment is required to calibrate this controller:

1. Differential Voltmeter with 10 mV full scale or less such as Fluke Model 871AB or a Portable Potentiometer such as the Barber-Colman Model PA11-1. Hewlett-Packard Model 427A.

2. Dc millivolt source with outputs of 0–1 mVdc and 0–100 mVdc. Source resistance must be 50 ohms or less.

3. Extender assembly 24-2 for Calibration or Troubleshooting.

Proceed through the following paragraphs in order. Do not skip a paragraph.

3.2.3.3 Calibration Check

THE EXAMPLES IN THIS CALIBRATION CHECK IN PARENTHESES ARE FOR RANGE CODE 0030 (0 to 2000° F, TYPE K).

1. Connect a millivolt source to the sensor input terminals. If the sensor is a thermocouple, be certain the correct thermocouple extension wire is used.

2. Set the millivolt source to the value shown in the Calibration Table for mid-scale temperature. (Example: 1000°F=22.25mV).

3. Connect a precision voltmeter to read the deviation voltage. Positive probe to pin 1 of P5, negative probe to pin 7 of P5.

4. Adjust the controller setpoint until the deviation voltage is 0 ± .025Vdc.

5. The setpoint reading must agree with the "Dial Setting" value shown in the Calibration Table within the rated accuracy of the instrument. (Example: 1001±20).

   ±1% of span plus 0.5% of suppression.

6. Set the millivolt source to the millivolt value corresponding to a temperature which is listed in the Calibration Table and which falls between 10 and 20% of span above the low point of the range. (Example: 200°F=3.82mV).

7. Adjust the controller setpoint until the deviation voltage is 0±.025Vdc.

8. The setpoint reading must agree with the "Dial Setting" value shown in the Calibration Table within the rated accuracy of the instrument. (Example: 208±20).

9. Set the millivolt source to the millivolt value corresponding to a temperature which is listed in the Calibration Table and which falls between 80 and 90% of span above the low point of the range. (Example: 1800°F=40.58mV).

10. Adjust the controller setpoint until the deviation voltage is 0±.025Vdc.

11. The setpoint reading must agree with the "Dial Setting" value shown in the Calibration Table within the rated accuracy of the instrument. (Example: 1790±20).

    ±1% of span plus 0.5% of suppression.

12. If the controller meets the accuracy specifications in steps 5, 8, and 11, the controller is properly calibrated. Do not make any internal adjustments or proceed further in the calibration procedure.

13. If the controller fails to meet the accuracy specifications in either step 5, 8, or 11, the controller must be calibrated.

Table 3-1 lists the adjustments on the Main Board. Always perform the adjustments on the Main Board first. When a Range Board is replaced, readjust R8 and R22 on the Main Board. After replacing either a Process Meter, or a Deviation Meter, readjust R10 on the Main Board.

If any repairs are made, all the adjustments on the Main Board, Control Mode Board (if any) and Output Board (if any) must be made.

Table 3-1. Summary of Adjustments on Main Board

Symbol	Description
R18	+15 Vdc Supply
R22	3 Vdc Setpoint Voltage (MID SPAN)
R8	6 Vdc Process Signal (MID SPAN)
R10	Process Meter Span or Deviation Meter Span

3.2.3.4 Meter Zero

Both the Process and Deviation Meters have a mechanical zero adjustment on the top of the meter. It is covered by tape. Remove the tape.

For the Deviation Meter with the instrument vertical, zero the meter with a non-magnetic screwdriver, and replace the tape. After a Deviation Meter is zeroed, place the instrument in the panel and be sure the meter is still at zero. This detects if any magnetic flux in the panel is present to offset the meter — if the meter is offset, zero it in the panel.

Apply 1Vdc across the terminals of the Process Meter before zeroing it.

Replace the tape.

3.2.3.5 ±15 Vdc Supply

A voltmeter capable of reading voltages to five significant figures in the range of 0–16 Vdc is required. Assuming such a voltmeter is available, proceed as follows:

1. Turn power on to the Series 520.

2. Set the voltmeter to read up to 16.000 Vdc.

3. Connect the probes of the voltmeter across the 15 Vdc supply (positive probe to pin 11 of P2, negative probe to pin 10). To locate these pins look at P2 on the Range Board. There are 11 pins on P2, and they are numbered 1 through 11, from left to right.

4. Adjust R18 until 15.000 Vdc±.015 Vdc is obtained.

5. Remove the probes.

6. Seal R18.

7. The -15 Vdc supply can be measured between pins 5 and 7 of P5 Output Board. Connect the positive probe to pin 7 and the negative probe to pin 5. The voltage read should not be less than 13.650 Vdc or more than 15.150 Vdc. To locate these pins first look at the board parts location drawing in the Output section of this manual.

8. Allow power to remain on to the instrument.

3.2.3.6 Setpoint

3.2.3.6.1 Digital

1. Turn the front panel SETPOINT ADJUST control to mid span of the setpoint range. (Example: 1000°F).

2. Set the voltmeter to read up to 4.000 Vdc.

3. Connect the positive probe of the voltmeter to pin 1 of P2 and the negative probe of the voltmeter to pin 10 of P2.

4. Adjust R22 until 3.000 Vdc±.003 Vdc is obtained.

5. Seal R22.

6. Allow power to remain on to the instrument.

3.2.3.6.2 Analog

1. Connect the positive probe of the voltmeter to the blue wire on the Analog Setpoint Board A-10503. Connect the negative probe to pin 10 of P2 on the Range Board.

2. Remove the setpoint knob.

3. Turn the SETPOINT ADJUST Control fully CCW. Observe the reading on the voltmeter. Slowly turn the SETPOINT ADJUST Control CW until a 25 mVdc change is observed on the voltmeter.

4. Reinstall the setpoint knob. Carefully align the pointer to the lowest scale value.

5. Adjust R5 on the Setpoint Board A-10503 for 1.000 Vdc±1 mVdc.

6. Turn the SETPOINT ADJUST Control fullscale.

7. Adjust R2 on the Setpoint Board for 5.000 Vdc±5 mVdc.

8. Repeat steps 5 through 7.

3.2.3.7 Deviation Signal Null

1. Adjust the front panel SETPOINT ADJUST control to the setting on the Calibration Table that corresponds to the midspan of the instrument. (Not necessarily the same as midspan of setpoint) (Example: 1001 setting = 1000°F).

2. Connect the dc millivolt source to input terminals 1 and 2. Be certain the polarity of the connections is correct.

3. Adjust the D.C. millivolt source for the equivalent millivolts of the same midscale temperature used in step 1. (Example: 1000°F=22.25mV).

4. Measure the deviation output of IC3A as follows: Connect the positive probe to pin 1 of P5, and the negative probe to pin 7 of P5. The precision voltmeter should read 0 Vdc ±.025 Vdc. Adjust R8 for zero deviation.

5. Seal R8, if Isolation Board is not present.

6. Allow power to remain on to the instrument.

7. If Isolation Board is installed, proceed to Isolation Board Adjustments and lastly do the Meter Span Adjustment.

3.2.3.8 Meter Span

If the controller has a Deviation Meter set the input source for the equivalent of midscale temperature and adjust the setpoint for the maximum deviation that corresponds to the deviation meter scale. For example, assume the controller has a 0 to 400°F range and a Deviation Meter with a scale marked -30 to 0 to +30. Adjust the setpoint to 230°F. Deviation Meter should read -30° to within one major division. Adjust R10 if it does not. Next, adjust the setpoint to 170°F. Deviation Meter should read +30°F to within one major division. Adjust R10 if it does not.

If the controller has a process meter, it should be indicating mid span when the dc millivolt source is set for the equivalent of midscale temperature. If it does not, adjust R10 until it does.

Allow power to remain on to the instrument and next perform any adjustments (if any) for the Control Mode and Output Sections, respectively, of this manual.

Table 3-2. Complete Main Board Assemblies

Assembly Number	Setpoint Option	Description of Feature Making Board Different from Other Main Boards
A-11410-100	4	Digital Setpoint
A-11410-200	5	Digital Setpoint with Remote–Local Switch
A-11410-300	6	Digital Setpoint with output setpoint voltage
A-11410-400	7	No setpoint. Requires remote setpoint voltage.
A-11410-500	8	Trim Setpoint. Requires remote setpoint voltage.
A-11410-600	1	Analog Setpoint
A-11410-700	2	Analog Setpoint with Remote–Local Switch
A-11410-800	3	Analog Setpoint with output setpoint voltage

Deviation Meter Part Numbers		
Part Number	Scale	Span (Units)
36-093-100	50-0-50	401-800
36-093-200	30-0-30	400 or less
36-093-300	100-0-100	801-1600
36-093-400	200-0-200	1601-3000
36-093	10-0-10	% Deviation

PROCESS METER
36-1XXXX
SPECIFY RANGE NUMBER WHEN ORDERING

FYRE-81 RECEPTACLE

A-10278 TRIM SETPOINT (△T) ASSEMBLY

PART OF ASSY A-10278

34-754 NO. 6 CLOSED END TERMINAL

DEVIATION METER

BLU

GRN

RED

BLK

BLU

GRY

GRN

GRN

WHT/GRN

PROCESS METER PART NUMBERS
PROCESS METER ASSEMBLY 36-1 XXXX
RANGE CODE OF INSTRUMENT

Adjustments on Main Board

Symbol	Description
R18	+ 15 Vdc Supply
R22	3 Vdc Setpoint Voltage (MID SPAN)
R8	6 Vdc Process Signal (MID SPAN)
R10	Process Meter Span or Deviation Meter Span

32-372 REMOTE LOCAL SWITCH
CONNECTIONS FOR USE WITH DIGITAL S.P.

LOCAL
REMOTE

SEE BELOW FOR ANALOG SETPOINT CONNECTIONS

GRN
YEL
WHT

RED
WHT/RED

PART OF ASSEMBLY A-10342 OR A-10343

SETPOINT SWITCH ASSEMBLIES		
Digits	Part Number	Digital Span
3	A-10342-100	0–X99
3	A-10342-200	200-X1199
3	A-10342-300	500-X1499
4	A-10343	0-X999
3	A-10342-400	1300-2399

ANALOG REMOTE–LOCAL SWITCH CONNECTIONS

LOCAL
REMOTE

GRN (TO POINT N – MAIN BOARD)
YEL (TO POINT M – MAIN BOARD)
BLU (FROM ANALOG SETPOINT – A-10503)

BLU
RED

PART OF ASSEMBLY A-10503

A-10503 ANALOG SETPOINT

WHT/RED

P1 SIGNAL
PROCESS
P2 SET POINT
ALARM
240 V
120 V
L2
LOAD
OUTPUT 2
OUTPUT 1
CURRENT
GND

BLK
BLK
BLK
BLK

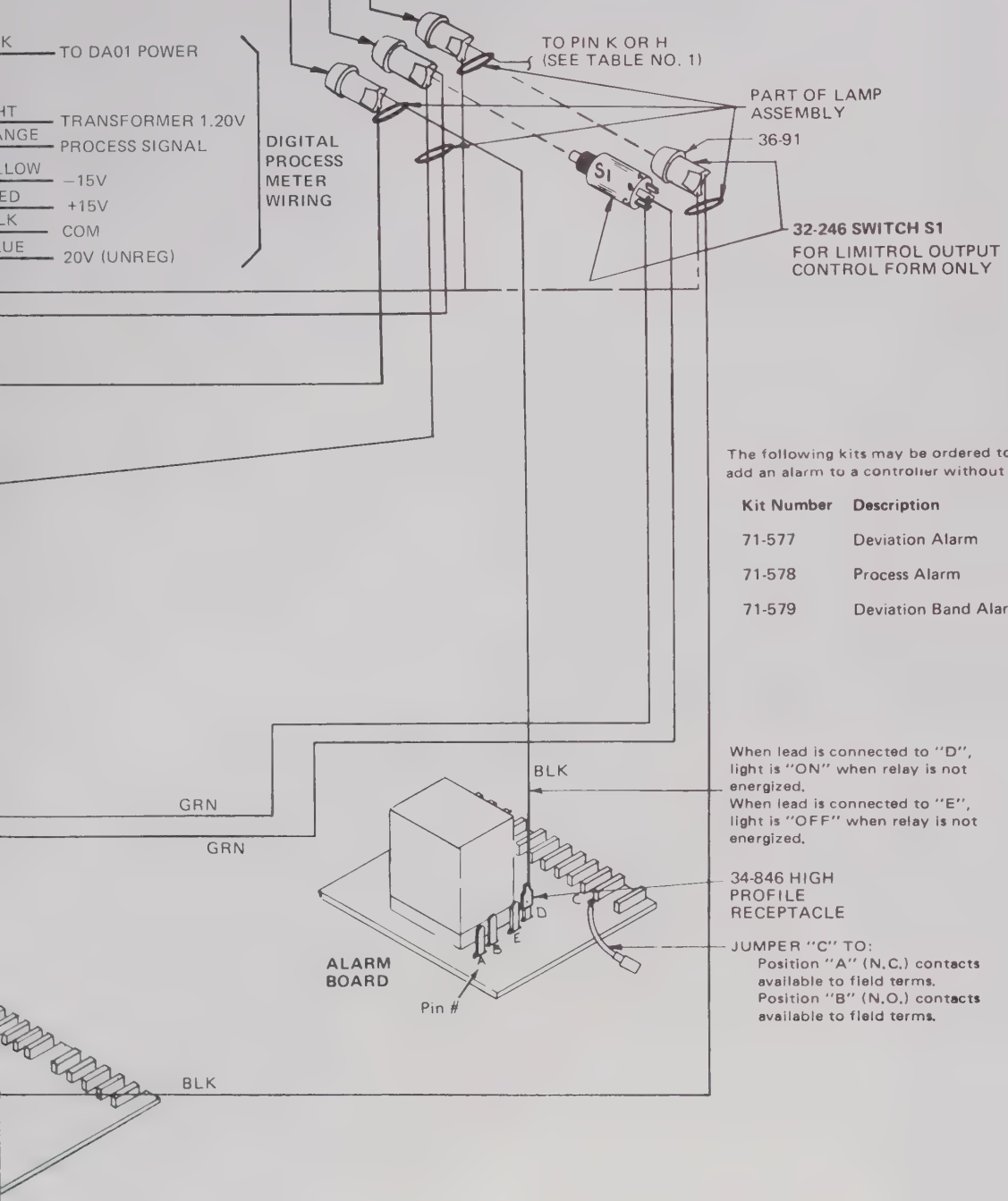
PURPLE
ORN
BLK
WHT/RED

LIMITROL OUTPUT ASSEMBLY CONTROL FORM BOARD

P3 CONTROL MODE
P5 CONTROL FORM

Figure 3-2. Wiring Diagram for All Models

Control Farm	Lamp and Connector	Pin Connection		Lamp and Connector	Pin Connection		Lamp and Connector	Pin Connection	
A, B	36-91-101 Red	I	Alarm Board D or E	None Required			36-111-100 Amber	G	K
C, D, P, Q								G	H
E, H								G	K
F, G, J, K				36-110-100 White	F	J		G	H
L or T				Switch (S1)	Part of Limitrol Bd.		36-112-100 Red	G	N.C. Contact of Relay



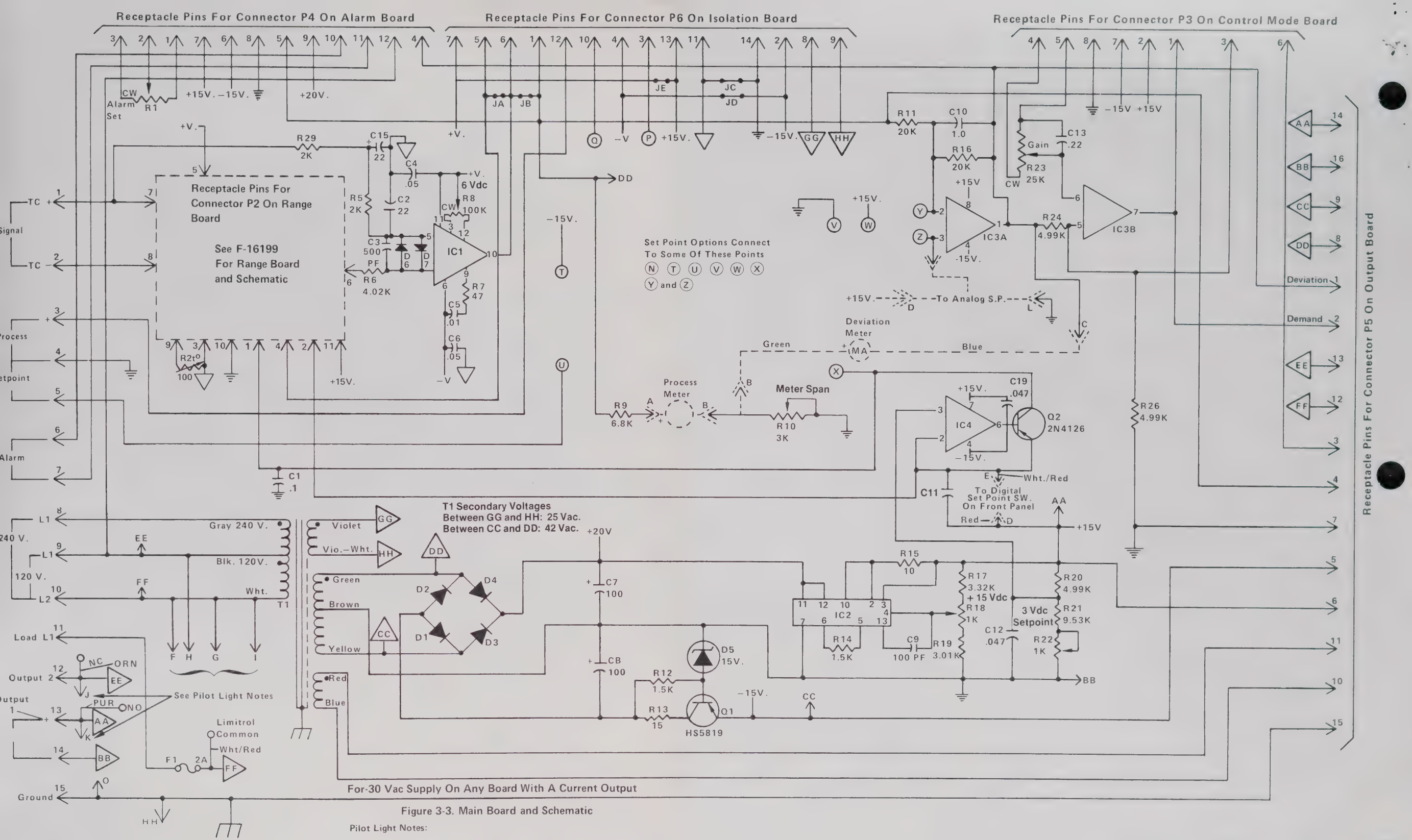
The following kits may be ordered to add an alarm to a controller without one.

Kit Number	Description
71-577	Deviation Alarm
71-578	Process Alarm
71-579	Deviation Band Alarm

When lead is connected to "D", light is "ON" when relay is not energized.
When lead is connected to "E", light is "OFF" when relay is not energized.

34-846 HIGH PROFILE RECEPTACLE

JUMPER "C" TO:
Position "A" (N.C.) contacts available to field terms.
Position "B" (N.O.) contacts available to field terms.



For-30 Vac Supply On Any Board With A Current Output

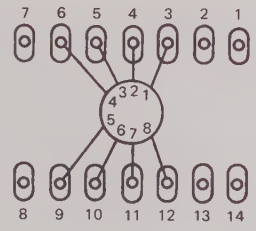
Figure 3-3. Main Board and Schematic

Pilot Light Notes:

1. For single time prop. or single on-off outputs, amber light is connected between pins G & K.
2. For dual time prop. or time prop. + on-off outputs, white light is connected between pins F & J and amber light is connected between pins G & K.
3. For current output, amber light is connected between pins G & H.
4. For current + on-off or current + time prop. outputs, white light is connected between pins F & J and amber light is connected between pins G & H.
5. For limitrol red light (left) is connected between pin G and N.C contact of limitrol relay. Common of limitrol relay is connected to pin H.
6. For optional alarms, red light is connected between pin 1 and pins D N.C. or E N.O. on alarm board.
7. Jumpers JA, JB, JC, JD and JE are clipped, and Isolation Board A 11121 is plugged in to make this board isolated

Table 3-3. Main Boards, Parts List

Symbol	Part Number	Description
	CAPACITORS	
C1	CYZR-803	.1μF 20%, 250WVDC
C2,15	39-414	22μF 10%, 15 WVDC
C3	39-387	500ρF 20%, 100 WVDC
C4,6	39-325	.05μF 20%, 100 WVDC
C5	39-103	.01μF 6 GMV, 100 WVDC
C7,8	39-163	100μF +100 -10%, 50 WVDC, Electrolytic
C9	39-069	100μF 5%, 600 WVDC
C10	CYZR-824	1ρF 20%, 100 WVDC
C11,12.19	39-449	.047μF 10%, 250 WVDC
C13	39-433	.22μF 10%, 250 WVDC
C14	39-400	10μF 20%, 15 WVDC (Only on A-11410-200, 400, & -700)
C18	39-449	.047μF 10%, 250 WVDC (Only on A-11410-300, -800)
	DIODES	
D1,2,3, 4,6,7	EYZP-384	Silicon, 250 PIV, 100 mA (Transition SG3087)
D5	37-204	Zener, 15V 5%, 400 mW
	FUSE	
F1	50-1223	20 Ampere, Type AGC 20 (Model 521L and 521T)
	SYZE-206	2 Ampere, Type AGC-2 (All other models)
	INTEGRATED CIRCUITS	
IC1	31-1011 or 31-1014	725C Operational Amplifier
IC2	31-1010	723C Voltage Regulator
IC3	31-1015 Dual	741C Minidip Operational Amplifier
IC4	31-1012	741C Minidip Operational Amplifier (omit on A-11410-600, -700, & -800)
	WIRE JUMPERS	
J1	Only on A-11410-300 & -800	
J2	Only on A-11410-300	
J3	Only on A-11410-400	
J4	Only on A-11410-100 & -300	
J5	Only on A-11410-500	
J6	Only on A-11410-300, -500 and -800	
J7	Only on A-11410-800	
	TRANSISTOR	
Q1	31-162	HS5819
Q2	EYZP-623	2N4126 (omit on A-11410-600, -700, & -800)
	RESISTORS	
Resistors are 10% tolerance, 1/4W, unless otherwise stated.		
R1	29-380	Process ALARM Potentiometer: 50k ohms, 3/4W
R1	29-374	Deviation ALARM Potentiometer: 5k ohms 20%
R2	MYDA-29-60	100 ohms 1%
R5,29	CYZR-861-230	2k ohms 1%, 1/8W
R6	CYZR-861-259	4.02k ohms 1%, 1/8W
R7	40-1751	47 ohms
R8	29-220	Variable, 100k ohms, 3/4W
R9	40-1922	6.8k ohms
R10	BYZR-162-5	Variable, 3k ohms 30%
R11	CYZR-861-330	20k ohms 1%, 1/8W
R12	CYZR-481-150	1.5k ohms
R13	CYZR-466	150 ohms
R14	CYZR-862-218	2.5k ohms 1%
R15	CYZR-481-350	4.7 ohms
R16	CYZR-862-330	20k ohms 1%
R17	CYZR-864-251	33.2k ohms .5%, 1/8W
R18	29-383	Variable, 1k ohm 20%, 1/2W
R19	CYZR-864-247	3.01k ohms .5%, 1/8W
R20	CYZR-864-268	4.99k ohms .5%, 1/8W
R21	CYZR-864-295	9.53k ohms .5%, 1/8W
R22	29-383	Variable, 1k ohm 20%, 1/2W
R23	29-370	GAIN Potentiometer, 25k ohms 30%
R24,26	CYZR-862-268	4.99k ohms 1%
R30	CYZR-861-301	10K ohms 1%, 1/8 W (Only on A-11410-200, -400, & -700)
	TRANSFORMER	
T1	30-346-2	Power



View for Installing 31-1011 (Round Can IC) In Place Of 31-1014 (D.I.P.)

For Continuation of Circuit See Figure 3-3.

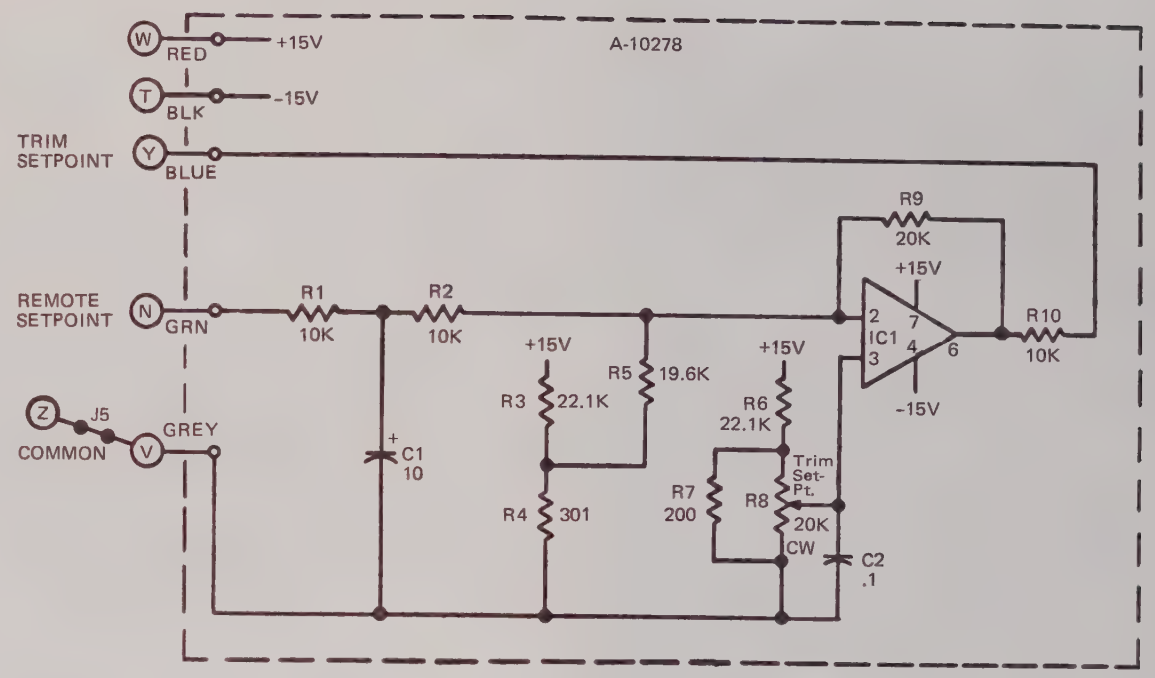
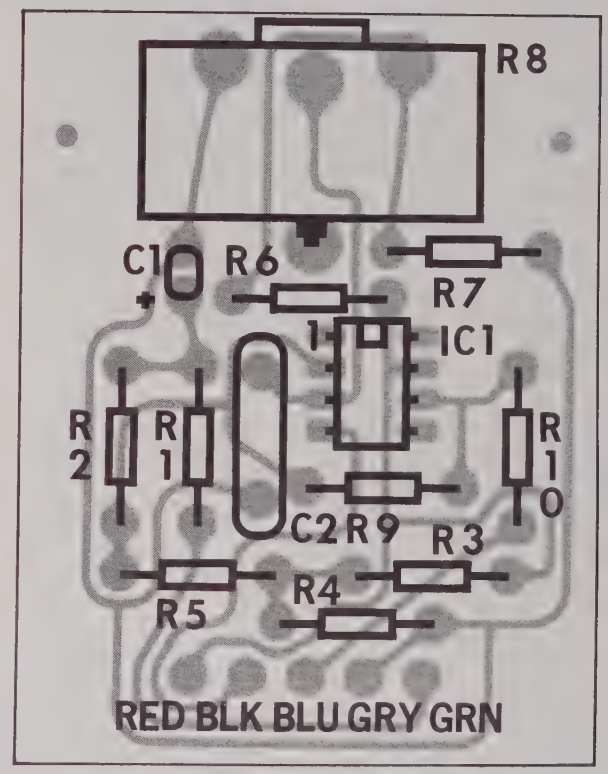


Table 3-4. Trim Setpoint Board A-10278 Parts List

Symbol	Part Number	Description
	CAPACITORS	
C1	39-400	10μF, 20%, 15 WVDC
C2	CYZR-803	.1μF, 10%, 250 WVDC
	INTEGRATED CIRCUIT	
IC1	31-1012	741C
	RESISTORS	
Resistors are 1%, 1/8W, unless stated otherwise.		
R1,2, 10	CYZR-861-301	10k ohms
R3,6	CYZR-861-334	22.1k ohms
R4	CYZR-861-147	301 ohms
R5	CYZR-861-329	19.6k ohms
R7	CYZR-861-130	200 ohms
R8	29-386	Variable, 20k ohms, 10%, 2W, W.W., TRIM Control
R9	CYZR-861-330	20k ohms

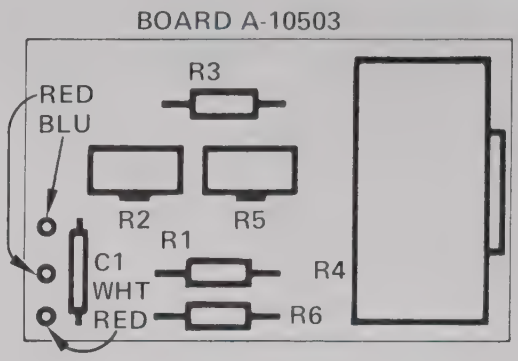


This board is located on the rear of the front panel mounted trim control.

Figure 3-4. Trim Setpoint Board and Schematic

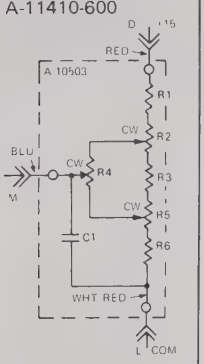
Table 3-3. Analog Setpoint Board A-10503 (Mounted on Analog Setpoint Pot)

Symbol	Part Number	Description
		CAPACITOR
C1	39-325	.05μF, 20%, 100 WVDC
		RESISTORS
R1	CYZR-864-256	3740 ohms, .5%, 1/8W
R2	29-399	Variable, 200 ohms, 20%, 1/2W
R3	CYZR-864-218	1500 ohms, .5%, 1/8W
R4	29-395	Variable, 20k ohms, 10%, 2W
R5	29-398	Variable, 100 ohms, 20%, 1/2W
R6	CYZR-861-151	332 ohms, 1%, 1/8W

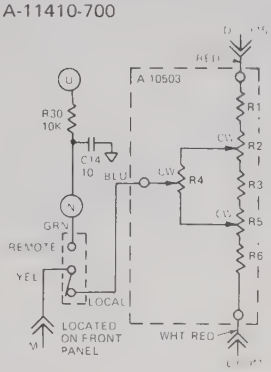


ANALOG OPTIONS

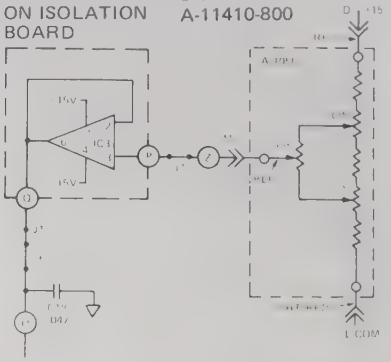
OPTION 1
ANALOG SETPOINT
ON MAIN BOARD: A-11410-600



OPTION 2
ANALOG SETPOINT WITH REMOTE-LOCAL SWITCH
ON MAIN BOARD: A-11410-700



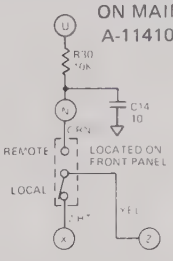
OPTION 3
ANALOG SETPOINT WITH OUTPUT SETPOINT VOLTAGE AVAILABLE
ON ISOLATION BOARD
ON MAIN BOARD: A-11410-800



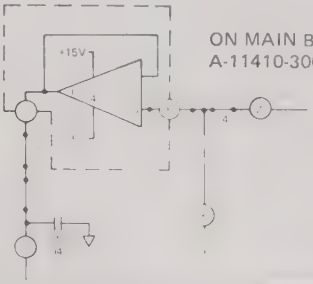
SETPOINT OPTIONS

OPTION 4
DIGITAL SETPOINT
ON MAIN BOARD: A-11410-100

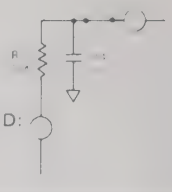
OPTION 5
DIGITAL SETPOINT WITH REMOTE–LOCAL SWITCH
ON MAIN BOARD: A-11410-200



OPTION 6 REMOTE SETPOINT
DIGITAL SETPOINT WITH OUTPUT SETPOINT VOLTAGE AVAILABLE
ON ISOLATION BOARD
ON MAIN BOARD: A-11410-300



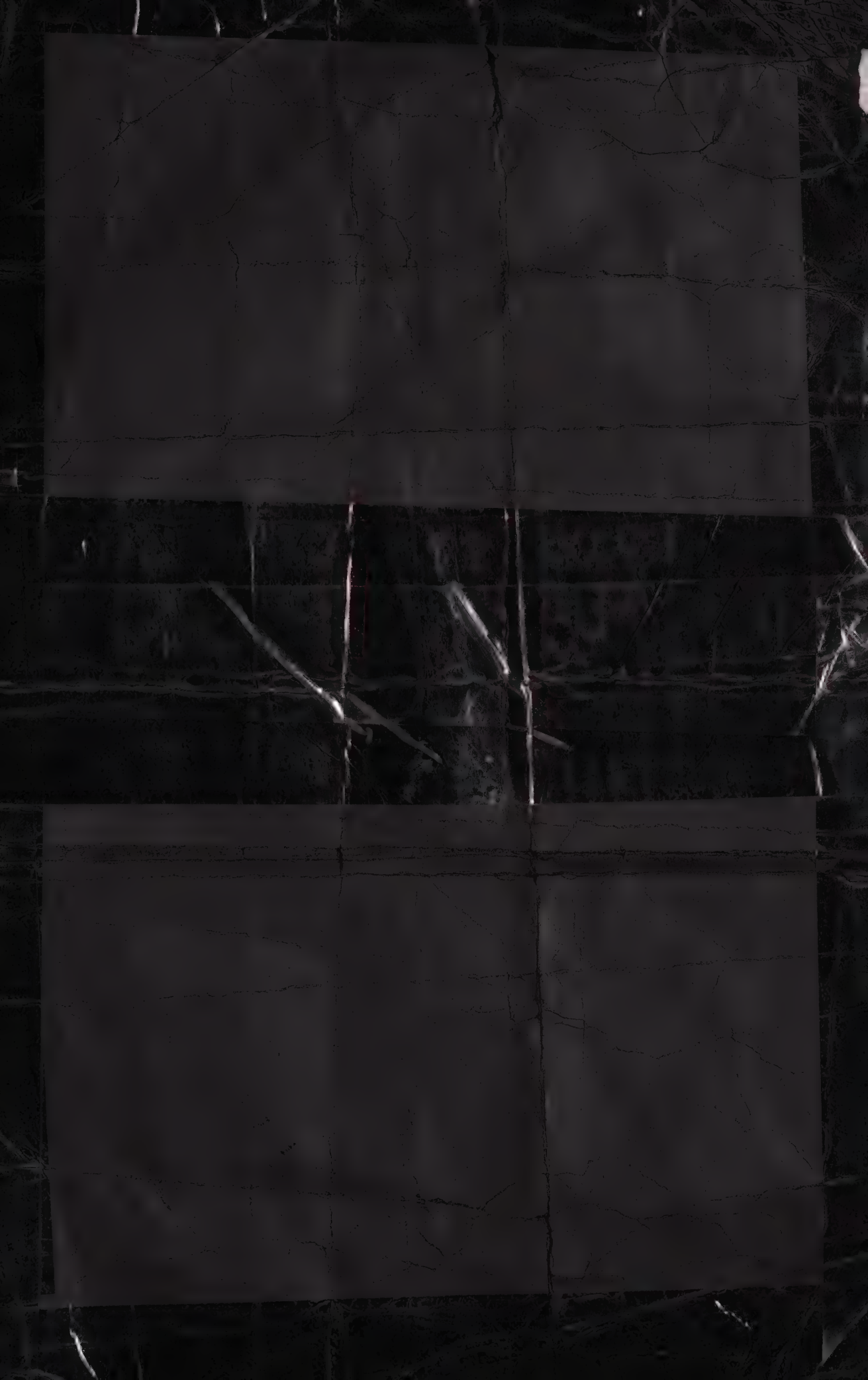
OPTION 7
REMOTE SETPOINT
ON MAIN BOARD:

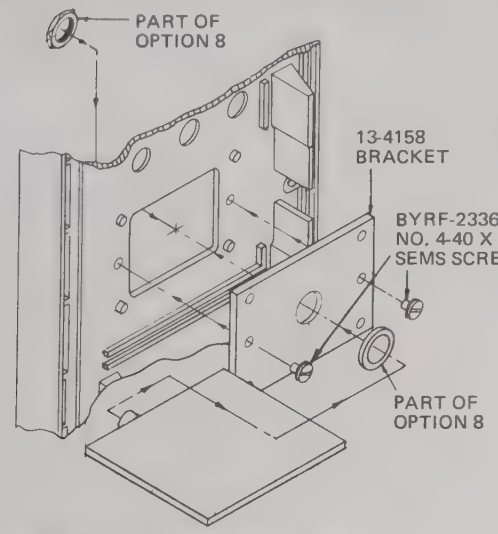


OPTION 8
WITH TRIM (△T)
FOR MAIN BOARD A-11410-500

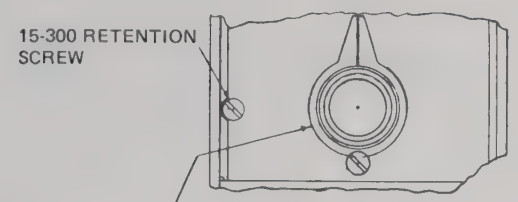
(See Fig. 3-4)

Connector P1 ——— These Pins Connect To Rear Panel Terminals





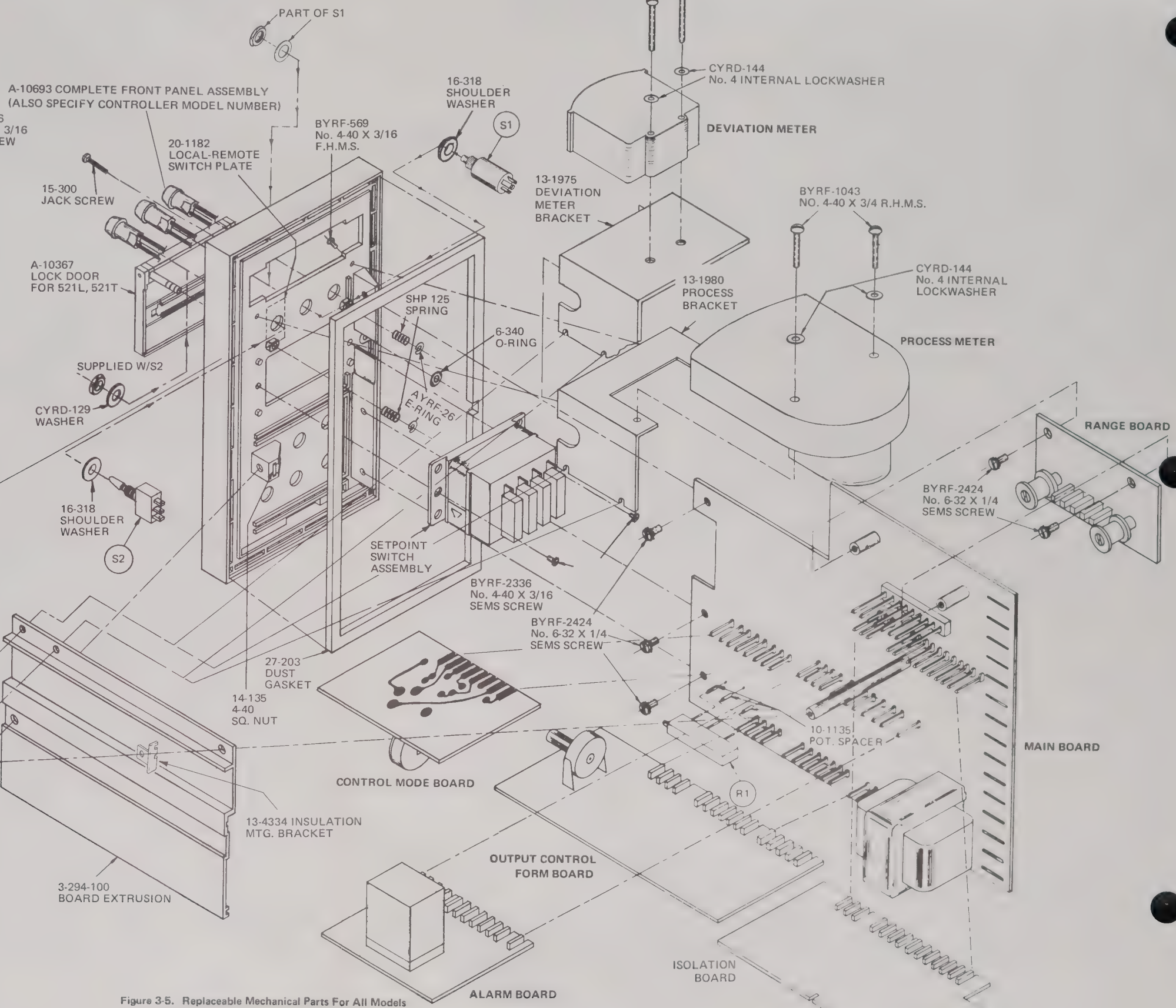
SETPOINT OPTION 8 – FRONT PANEL



BEIGE PLASTIC MOLD

ANALOG AND 3-DIGIT: 6-465-101

4-DIGIT: 6-464-101



Parts for all Models are shown –
Many will not be on your Model

Figure 3-5. Replaceable Mechanical Parts For All Models

A-10334—001—X—X X

Basic Part Number

Factory Use

Type of Mounting
2 — Standard relay rack panel
3 — Standard relay rack panel with conduit box

Number of Instruments Aligned Horizontally
Insert a number from 1 to 5

Number of Instruments Aligned Vertically
Insert 1

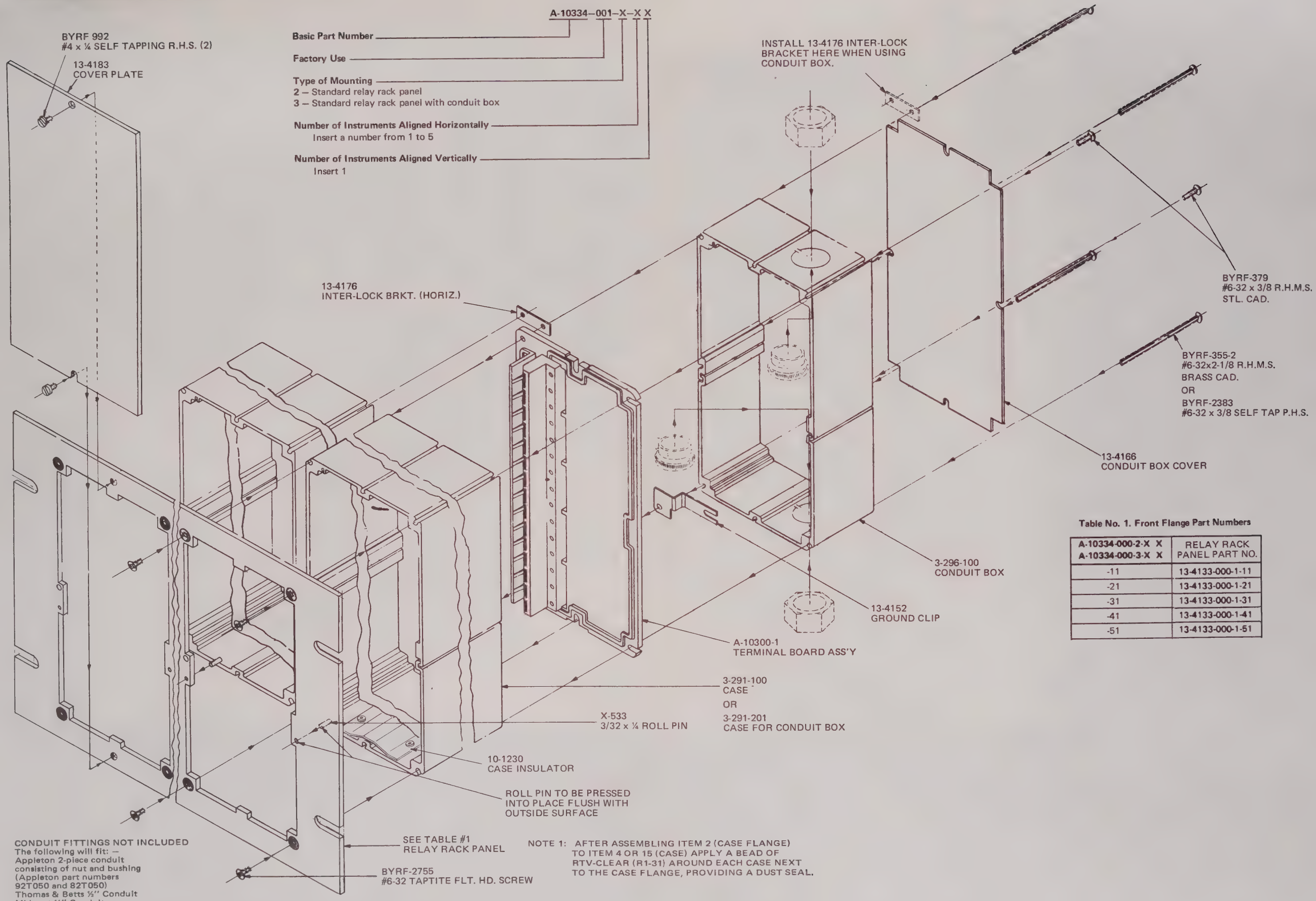


Table No. 1. Front Flange Part Numbers

A-10334-000-2-X X A-10334-000-3-X X	RELAY RACK PANEL PART NO.
-11	13-4133-000-1-11
-21	13-4133-000-1-21
-31	13-4133-000-1-31
-41	13-4133-000-1-41
-51	13-4133-000-1-51

CONDUIT FITTINGS NOT INCLUDED
The following will fit: —
Appleton 2-piece conduit consisting of nut and bushing (Appleton part numbers 92T050 and 82T050)
Thomas & Betts ½" Conduit
Midwest ½" Conduit

NOTE 1: AFTER ASSEMBLING ITEM 2 (CASE FLANGE) TO ITEM 4 OR 15 (CASE) APPLY A BEAD OF RTV-CLEAR (R1-31) AROUND EACH CASE NEXT TO THE CASE FLANGE, PROVIDING A DUST SEAL.

Figure 3-6. Replaceable Parts, Housings for Standard Relay Rack

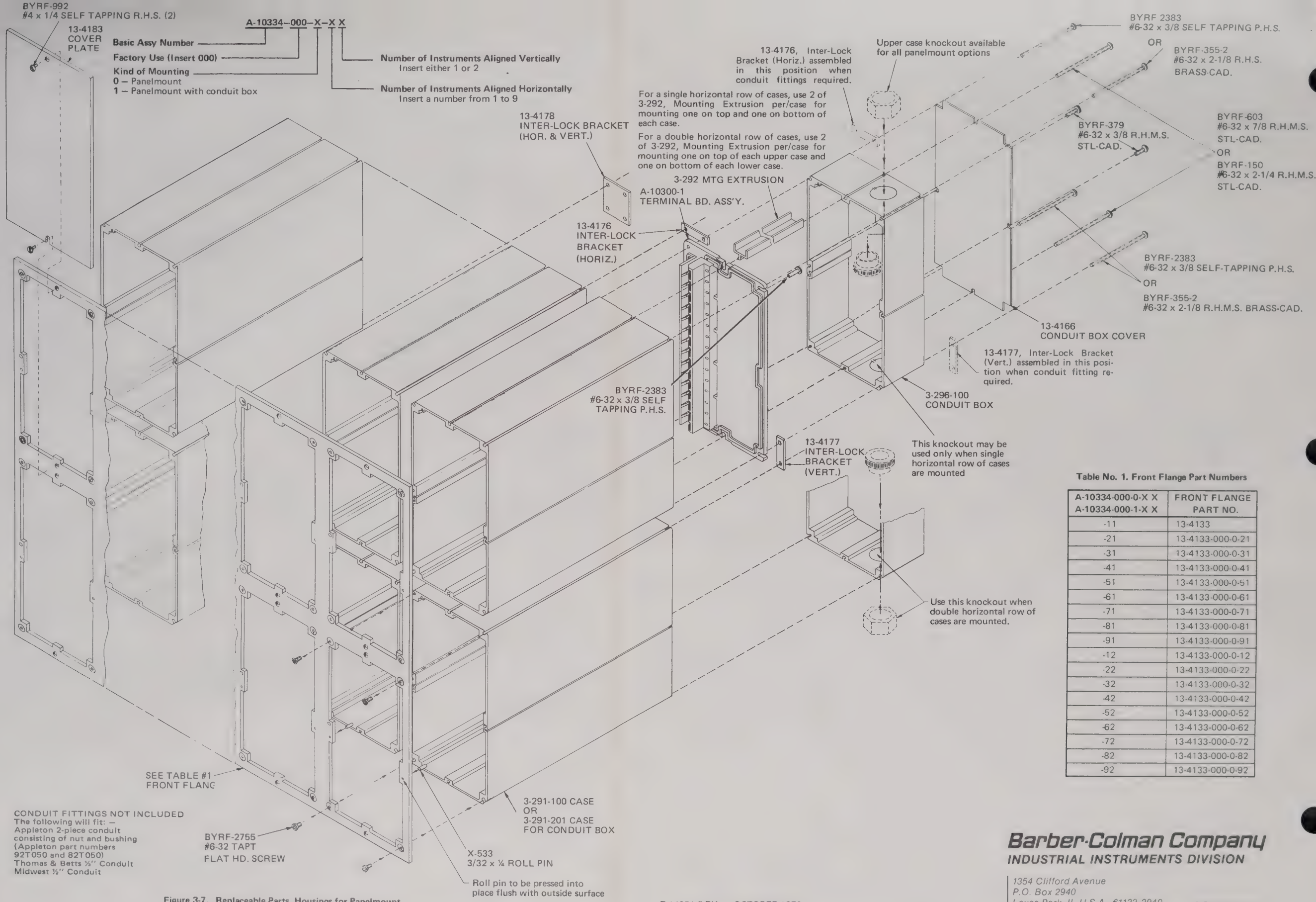


Figure 3-7. Replaceable Parts, Housings for Panelmount

Table No. 1. Front Flange Part Numbers

A-10334-000-0-X X A-10334-000-1-X X	FRONT FLANGE PART NO.
-11	13-4133
-21	13-4133-000-0-21
-31	13-4133-000-0-31
-41	13-4133-000-0-41
-51	13-4133-000-0-51
-61	13-4133-000-0-61
-71	13-4133-000-0-71
-81	13-4133-000-0-81
-91	13-4133-000-0-91
-12	13-4133-000-0-12
-22	13-4133-000-0-22
-32	13-4133-000-0-32
-42	13-4133-000-0-42
-52	13-4133-000-0-52
-62	13-4133-000-0-62
-72	13-4133-000-0-72
-82	13-4133-000-0-82
-92	13-4133-000-0-92

F-14851-5 BK OCTOBER 1976

Barber-Colman Company
INDUSTRIAL INSTRUMENTS DIVISION
1354 Clifford Avenue
P.O. Box 2940
Loves Park, IL U.S.A. 61132-2940

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DIGITAL INDICATOR ASSEMBLY, A-11892-XXX

GENERAL

This bulletin is a supplement to F-14851 for controller Models 521, 522, 523, and 524; and to F-15098 for High-Power Switching Models 525, 526, 527, and 528.

Digital Indicator Assembly, A-11892-XXX is the horizontal circuit board located in the upper front area on 520 Series Controllers. The power transformer for the Digital Indicator is mounted under the A-11892-XXX circuit board.

DESCRIPTION

Model A-11892-000 (4-Digit Indicator) can display ranges from -400 to +1999. Model A-11892-100 (5-Digit Indicator) can display ranges from -4000 to +19999.

FEATURES

- 4 or 5-Digit Bipolar Display with Automatic Polarity Indication.
- Accurate Analog-to-Digital Conversion using Dual-Slope Integration.
- Overrange Blanking (Display shows -1 _ _ _)
- High Resolution Zero and Span Adjustments
- Advanced Design Requires Fewer Active Components (Two Integrated Circuits perform all basic functions)

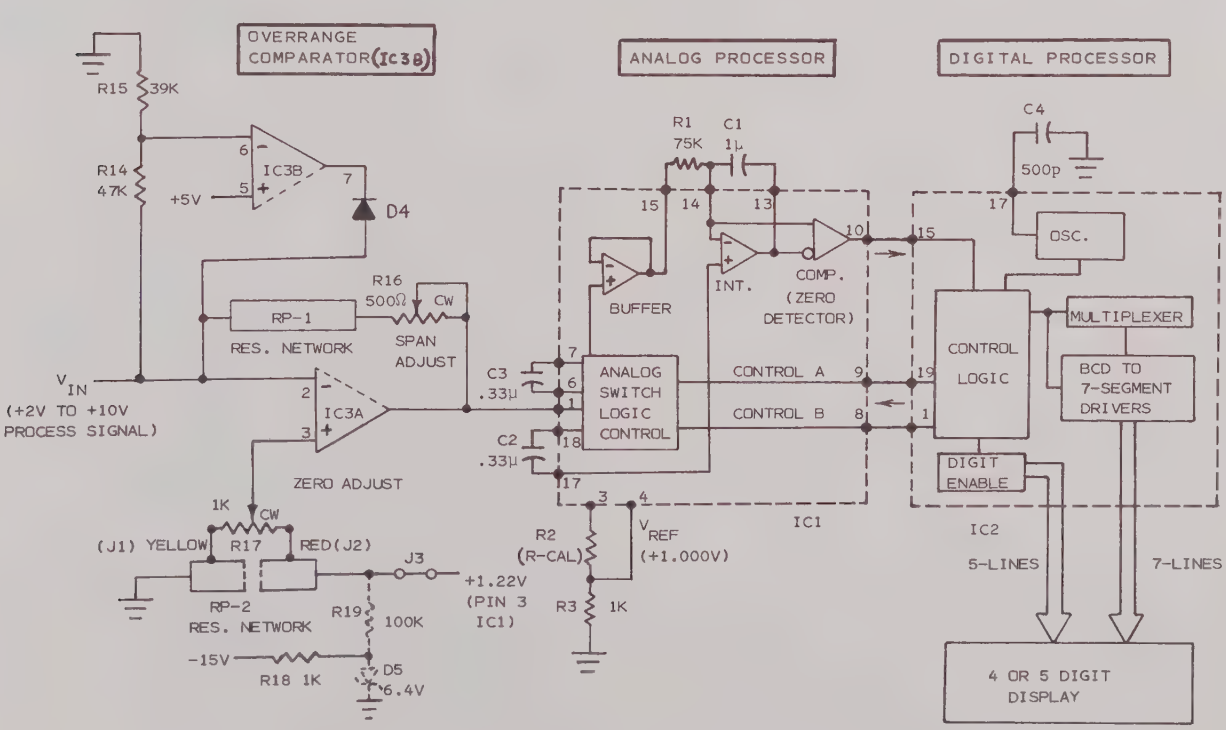


FIGURE 1. A-11892-XXX DIGITAL INDICATOR BLOCK DIAGRAM

CIRCUIT DESCRIPTION AND OPERATION

The advanced design of the A-11892-XXX Digital Indicator requires fewer active components to perform all basic functions for digital display of process temperature.

Power requirements for the Digital Indicator are +5 Vdc (provided by the A-11892-XXX circuit board supply) and -8 Vdc minimum (derived from the -15 Vdc supply on the 520 main board).

High accuracy is achieved in Analog-to Digital signal conversion by utilizing the proven method of Dual-Slope Integration. Analog Processor, IC1, and Digital Processor, IC2, form the heart of the system. Operating together, they convert a conditioned analog Process signal to drive the large (.362"), easy to read, digital display.

Process input (V_{IN}), +2 to +10 Vdc, is attenuated or scaled by IC3A providing up to ±2 Vdc output before entering Analog Processor, IC1. ZERO and SPAN adjustments (R17 and R16) are 25 turn potentiometers (providing high resolution) for final calibration of the digital indicator.

Shorting Block Jumpers (1 through 6), Soldered Wire Jumpers (J1, J2, and J3), and selected components (D5 and R19) must be added or omitted as described in Range Selection Table 3.

For ranges not listed, consult factory for correct jumper and component arrangement.

Overrange Comparator IC3B will generate an output signal to blank the display (-1 _ _ _) whenever the maximum Process temperature (as setup in Range Selection Table 3) is exceeded. A process input signal (V_{IN}) over +11 Vdc will drive the output of IC3B to -6 Vdc. The output of IC3A is then driven to +3.75 Vdc signaling IC1 and IC2 to blank the display (-1 _ _ _).

Analog Processor, IC1, performs several functions including generation of an accurate and stable source voltage. This source voltage is used to establish the reference voltage needed (at pin 4 of IC1) for Dual-Slope Integration.

The source voltage used (+1.22 Vdc ±8%) for establishing the reference is internally generated by IC1 and appears at pin 3. Resistors R2 (R-CAL) and R3 (1KΩ) divide this stable source voltage to the required +1.000 Vdc reference value (at pin 4 of IC1) for Dual-Slope Integration.

The source voltage at pin 3 of IC1 can range from +1.1200 Vdc to +1.3200 Vdc. Resistor R2 (R-CAL) is selected from Table 2 to provide the final +1.000 Vdc ±1% reference voltage required at pin 4.

IC1 also provides: 1) automatic compensation of internal zero offsets (in IC1) via Capacitor C2, 2) integrates the differential voltage across pins 1 and 2 through C1 and R1, and 3) integrates the negative of the reference voltage stored on C3. The final output on IC1 (pin 10) is a high or low comparator signal. Two control lines (from IC2) appear at IC1 input pins 8 and 9 to control the Internal Logic Switch.

Digital Processor, IC2, is designed to complement Analog Processor, IC1. It features overrange blanking, an internal 120 KHz oscillator (set by C4), 7-segment display output drivers, and 5 multiplexed digit-enable outputs. Advanced I^2L and bi-polar technology is used in manufacturing this device.

IC2 input pin 15 monitors the comparator output from pin 10 of IC1 while output pins 1 and 19 provide high or low logic signals (to pins 8 and 9 of IC1) for controlling the Internal Logic Switch of Analog Processor, IC1.

Display circuit board assembly A-11893 has 4 L.E.D. display digits for a maximum reading of 1999. Assembly A-11893-100 has 5 digits for a maximum display of 19999. The digital indicator may be converted from a 4-digit to a 5-digit display by soldering DSP-1 (B-C Part Number: E17-33) in place and modifying the main digital indicator board according to Range Selection Table 3.

On the Display circuit board assembly, digit enable transistors Q1 through Q5 are controlled by five Digit Enable output lines from Digital Processor, IC2. Individual digit segments are controlled by the 7-segment Driver output lines.

Resistor,R1 (22Ω) may be added to the Display circuit board to provide an optional decimal point.

Decimal Point Location	R1 Position
None	Omit
Between DSP-4 and DSP-3	1 to A
Between DSP-3 and DSP-2	1 to B

FIGURE 2. A-11892-XXX DIGITAL INDICATOR SCHEMATIC

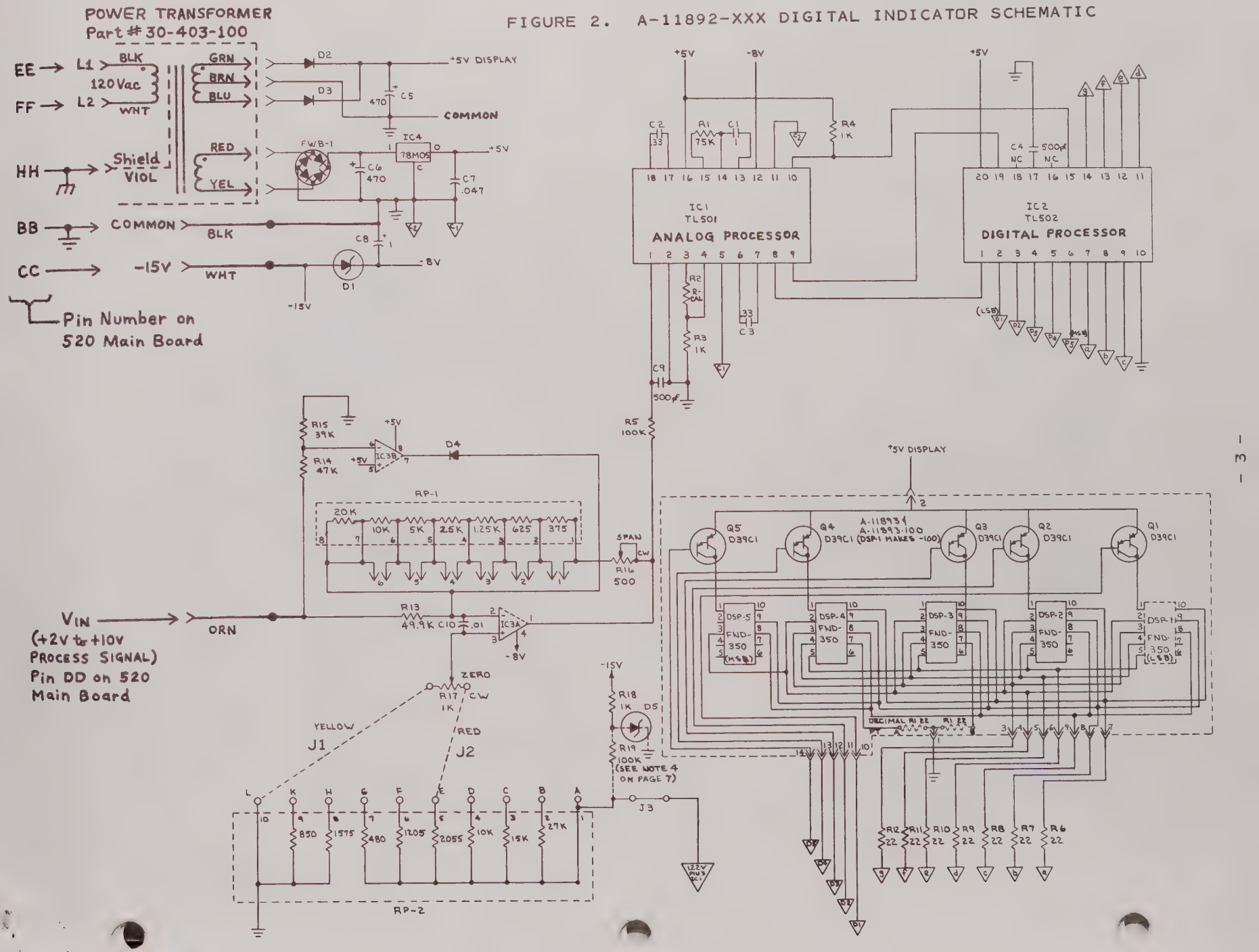
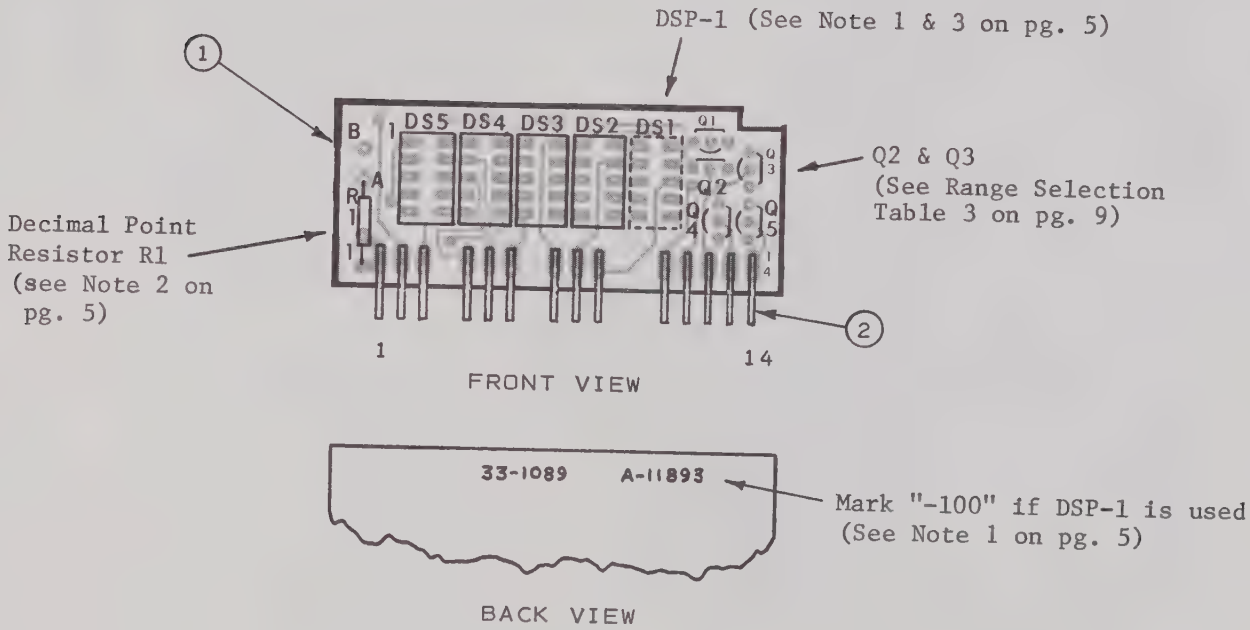
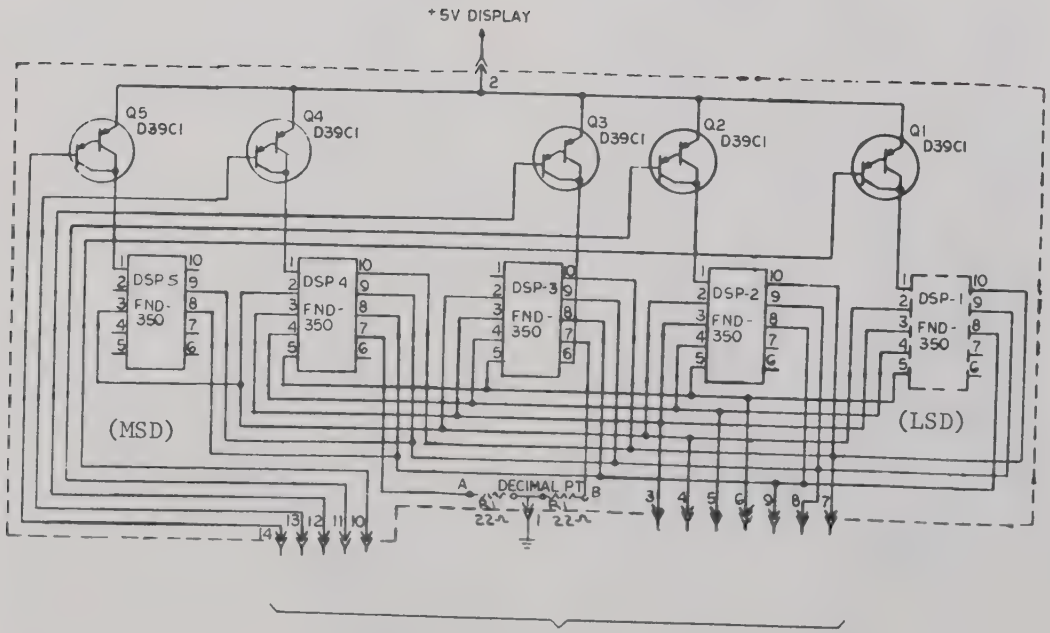


FIGURE 3. LED DISPLAY CIRCUIT BOARD, A-11893-XXX, AND SCHEMATIC





Connects To Digital Indicator
Main Board, A-11892-XXX

TABLE 1. DIGITAL INDICATOR ASSEMBLIES

DIGITAL INDICATOR ASSEMBLY NUMBER	DIGIT DISPLAY BOARD ASSEMBLY NUMBER
A-11892-000	A-11893, 4-DIGIT P.C.B. ASSEMBLY
A-11892-100	A-11893-100, 5-DIGIT P.C.B. ASSEMBLY (NOTE #1)

PARTS LIST FOR DISPLAY CIRCUIT BOARD, A-11893-XXX:

ITEM	PART NUMBER	DESCRIPTION
DSP-1	E17-33	L.E.D.,NUMERIC DISPLAY, FND 350 (ADD DSP-1 TO MAKE 5-DIGIT DISPLAY BOARD, A-11893-100. SEE NOTE #1).
DSP-2	E17-33	L.E.D.,NUMERIC DISPLAY, FND 350
DSP-3	E17-33	L.E.D., NUMERIC DISPLAY, FND 350
DSP-4	E17-33	L.E.D., NUMERIC DISPLAY, FND 350
DSP-5	E17-33	L.E.D., NUMERIC DISPLAY, FND 350
Q1-Q5	E20-61	TRANSISTOR, SILICON, PNP, DARLINGTON D39C-1
R1	E19-35-34	22Ω, ¼W, ±10%, CARBON (SEE NOTE #2)
(1)	33-1089	P.C.B.
(2)	34-881-1	"F" POST (14 REQUIRED)

NOTES FOR DISPLAY CIRCUIT BOARD, A-11893-XXX:

1. To make a 5-digit Display Board (A-11893-100), Item DSP-1 should be soldered in place and "-100" added to assembly number.
2. Decimal Point position may be selected by adding Resistor R1 (22Ω, ±10%, ¼W) as follows:

   For Decimal Point between DSP-4 and DSP-3, solder R1 into holes 1 and A on Digit Display Board.

   For Decimal Point between DSP-3 and DSP-2, solder R1 into holes 1 and B on Digit Display Board.
3. Mounting holes for LED Display Digit, DSP-1, are not solder filled.
4. All LED Display Digits should have the same brightness code. Code number (05, 06, 07, etc.) is located on right side of digit package.

FIGURE 4. DIGITAL INDICATOR ASSEMBLY, A-11892-XXX

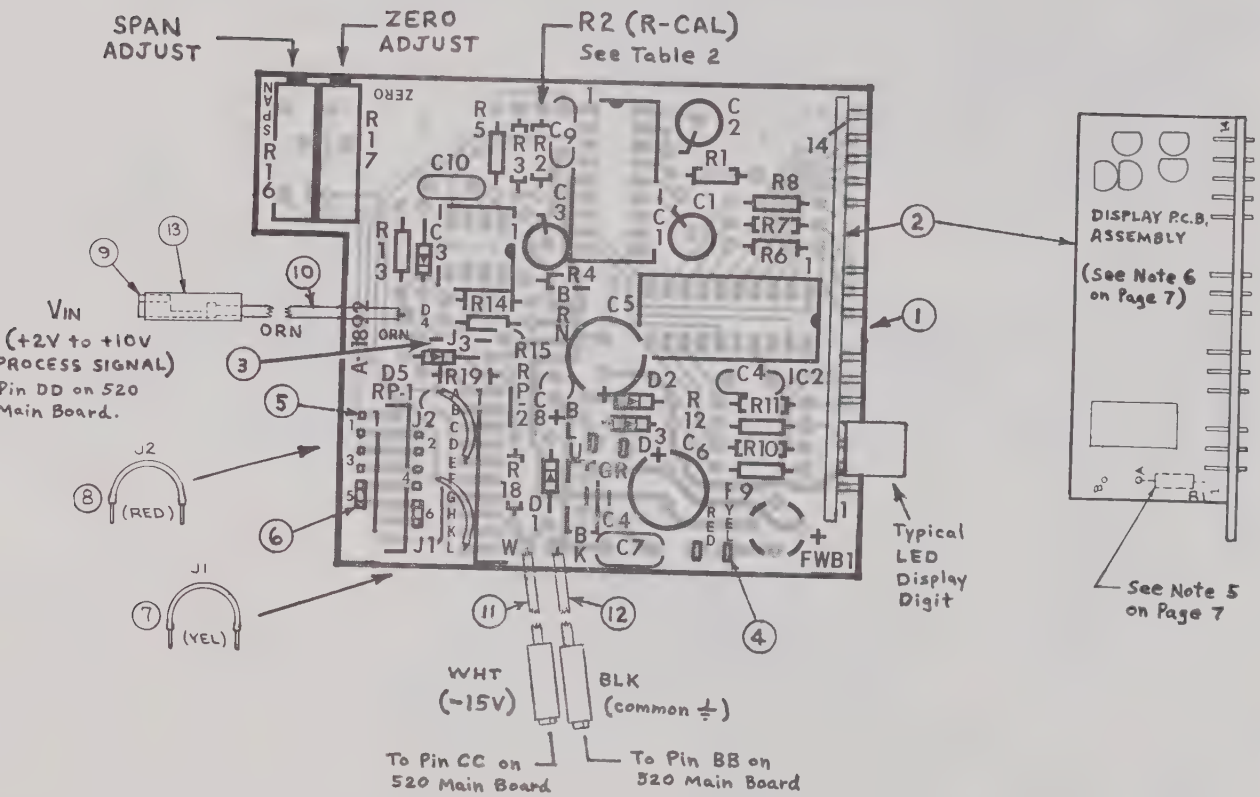


TABLE 2. DETERMINING R2 (R-CAL)
(See Note 7 on pg. 7)

R2 (R-CAL)		REF. SOURCE VOLTAGE (IC1, PIN 3 TO ⏚)
PART NUMBER	DESCRIPTION	
CYZR-788-058	130Ω, 1/8W, ±1%, MF	+1.1200 to 1.1400
CYZR-837-200	150Ω, 1/8W, ±1%, MF	+1.1401 to 1.1600
E19-24-123	169Ω, 1/8W, ±1%, MF	+1.1601 to 1.1800
CYZR-862-128	191Ω, 1/4W, ±1%, MF	+1.1801 to 1.2000
CYZR-862-132	210Ω, 1/4W, ±1%, MF	+1.2201 to 1.2200
CYZR-837-948	237Ω, 1/8W, ±1%, MF	+1.2201 to 1.2400
E19-24-139	249Ω, 1/8W, ±1%, MF	+1.2401 to 1.2600
CYZR-722-10	267Ω, 1/4W, ±1%, MF	+1.2601 to 1.2800
CYZR-868-004	294Ω, 1/8W, ±1%, MF	+1.2801 to 1.3000
CYZR-864-147	301Ω, 1/8W, ±.5%, MF	+1.3001 to 1.3200

NOTES FOR DIGITAL INDICATOR ASSEMBLY, A-11892-XXX:

1. Jumper J1 (Yellow wire) is soldered to 'L' and J2 (Red wire) is soldered to 'E'. Both jumpers may be repositioned as required per Range Selection Table 3 (Pg. 9).

2. Jumper J3 (Bare wire) is soldered in place but may be omitted as required per Range Selection Table 3.

3. Shorting Block Jumpers may be added or relocated as required per Range Selection Table 3. If additional Block Jumpers are needed, order B-C No. 71-045 (package of 2 Block Jumpers, 34-923).

4. D5 and R19 to be inserted as required per Range Selection Table 3.

5. Decimal Point position (optional) may be selected by adding Resistor R1 (22Ω, ±10%, ¼W) as follows:

   For Decimal Point between DSP-4 and DSP-3, solder R1 into holes 1 and A on Digit Display Board.

   For Decimal Point between DSP-3 and DSP-2, Solder R1 into holes 1 and B on Digit Display Board.

6. To make a 5-digit Display Board (A-11893-100), Item DSP-1 should be soldered in place and "-100" added to assembly number.

7. The value of Resistor R2 (R-CAL) is selected to provide a +1.000 V reference V_{REF} (at pin 4 of IC1) for Dual-Slope Integration. The value for R2 varies with the source voltage measured at pin 3 of IC1.

   Source voltage is measured and the correct value for R2 (R-CAL) is soldered in place at the factory. Selection of R2 (R-CAL) is not part of the field calibration procedure and need not be changed unless IC1 is replaced.

PARTS LIST FOR DIGITAL INDICATOR MAIN BOARD ASSEMBLY, A-11892-XXX

ITEM	PART NUMBER	DESCRIPTION	QUANTITY
C1	39-455	1µF, ±10%, 50 WVDC, METALLIZED POLYCARBONATE	
C2,C3	39-451	.33µF, ±20%, 50 WVDC, METALLIZED MYLAR	
C4	39-387	500 pF, ±20%, 100 WVDC, CERAMIC	
C5,C6	E13-93	70µF, -10%, +100%, 16 WVDC, ALUMINUM ELECT.	
C7	39-325	.047µF, ±10%, 100 WVDC, MYLAR	
C8	39-382	1µF, ±20%, 35 WVDC, TANT.	
C9	39-387	500 pF, ±20%, 100 WVDC, CERAMIC	
C10	39-311	.01µF, +80%, -20%, 50 WVDC, CERAMIC	
D1	E20-18	6.2V, ±5%, ZENER DIODE, IN753A, 400 mW	
D2,D3	37-66	SILICON DIODE, IN4005, PIV 500, If = 1A	
D4	EYZP-384	SILICON DIODE, SG3087, PIV 250, If = 100 mA	
D5	E20-128	6.4V, ±5%, TEMP. COMP., ZENER DIODE, IN4577, 400 mW (SEE NOTE #4, PG. 7)	
FWB1	37-182	FULL WAVE BRIDGE, W-113	
IC1	E21-182	I.C., A/D CONVERTER, TL501	
IC2	E21-183	I.C., LOGIC CONTROLLER, TL502	
IC3	31-1015	I.C., DUAL OP AMP, SA1458V	
IC4	E21-171	I.C., VOLTAGE REGULATOR, µA78M050C	
R1	CYZR-932-065	75K, ±1%, 1/8W, MF	
R2	---	(R-CAL) SEE TABLE 2 (PG. 6) AND NOTE 7 (PG. 7)	
R3	E19-24-201	1K, 1%, 1/8W, MF	
R4	CYZR-481	1K, ±10%, 1/4W, CARBON	
R5	40-1314	100K, ±10%, 1/4W, CARBON	
R6-R12	E19-35-34	22Ω, ±10%, 1/4W, CARBON	
R13	CYZR-861-368	49.9K, ±1%, 1/8W, MF	
R14	40-1847	47K, ±10%, 1/4W, CARBON	
R15	40-1845	39K, ±10%, 1/4W, CARBON	
R16	E19-220	500Ω, ±10%, 3/4W, 25 TURN POT	
R17	E19-221	1K, ±10%, 3/4W, 25T, POT	
R18	CYZR-481	1K, ±10%, 1/4W, CARBON	
R19	CYZR-788-023	100K, ±1%, 1/8W, MF, (SEE NOTE #4, PG. 7)	
RP-1	40-2044	RESISTOR PACKAGE, 8-PIN	
RP-2	40-2045	RESISTOR PACKAGE, 10-PIN	
①	33-1090	P.C.B. (DIGITAL PROCESS METER)	1
②	A-11893-XXX	DISPLAY ASSEMBLY (SEE TABLE 1, PG. 5)	1 (NOTE 6, PG. 7)
③	47-414	INSERTABLE BARE WIRE JUMPER	1 (NOTE 2, PG. 7)
④	34-847	MOD 1 PIN	5
⑤	34-904	MOD 2 PIN	12
⑥	34-923	SHORTING BLOCK JUMPER	AS REQ'D (NOTE 3, PG. 7)
⑦	47-4026	22 AWG, YELLOW WIRE, L = 2"	1 (NOTE 1, PG. 7)
⑧	47-4025	22 AWG, RED WIRE, L = 2"	1 (NOTE 1, PG. 7)
⑨	34-861	MOD 1 RECEPTACLE	3
⑩	47-4079	22 AWG, ORANGE WIRE, L = 5"	1
⑪	47-4027	22 AWG, WHITE WIRE, L= 8"	1
⑫	47-4027	22 AWG, BLACK WIRE, L = 8"	1
⑬	R4-72	SLEEVING 3/4" LONG	3

TABLE 3. RANGE SELECTION

RANGE (NOTE 1)	J1 YELLOW	J2 RED	J3 BARE WIRE (NOTE 2)	BLOCK JUMPER(S) REQUIRED (ITEM #6)	R19 (NOTE 3)	D5 (NOTE 3)	R1 POSITION FOR DECIMAL POINT (NOTE 4)	DPM MAIN BOARD (NOTE 5)	DSP-1 LED DISPLAY DIGIT (NOTE 6)	DISPLAY BOARD TRANSISTORS (NOTE 7) Q2	DISPLAY BOARD TRANSISTORS (NOTE 7) Q3	COMMENTS
-400 TO 0	K	F		4,5,6								
-300 TO 0	L	E		2,4,5,6								
-200 TO 0	L	E		3,4,5,6								
-100 TO 0	L	E		2,3,4,5,6,								
-5 TO 0	K	F		2,3,5,6,			HOLES 1 & A			CLIP		DISPLAYS 5.0
0 TO 10	L	E		3,4,6,			HOLES 1 & A			CLIP		DISPLAYS 10.0
0 TO 50	L	E		2,3,5,6,			HOLES 1 & A			CLIP		DISPLAYS 50.0
0 TO 100	L	E		3,4,6,						CLIP		
0 TO 200	L	E		4,5,								
0 TO 300	L	E		2,4,5,6,								
0 TO 400	L	E		4,5,6,								
0 TO 500	L	E		2,3,5,6,								
0 TO 600	L	E		3,5,6,								
0 TO 700	L	E		2,5,6,								
0 TO 800	L	E		5,6,								
0 TO 900	L	E		2,3,4,6,								
0 TO 1000	L	E		3,4,6,								
0 TO 1200	L	E		4,6,								
0 TO 1400	L	E		3,6,								
0 TO 1600	L	E		6								
0 TO 1800	L	E		3,4,5,								
0 TO 2000	K	F		4,5								
0 TO 2500	K	B		1,2,4,5,6,				A-11892-100	ADD			
0 TO 3000	K	B		2,4,5,6,				A-11892-100	ADD			
0 TO 4000	H	B		4,5,6				A-11892-100	ADD			
0 TO 5000	K	D		2,3,5,6,				A-11892-100	ADD			
0 TO 10000	H	D		3,4,6,				A-11892-100	ADD			
200 TO 800	L	C	OUT	3,5,6,	JUMPER	IN						
200 TO 1200	L	E		3,4,6,								
500 TO 1500	L	C	OUT	3,4,6,	JUMPER	IN						
1300 TO 2300	K	B	OUT	3,4,6,	IN	IN		A-11892-100	ADD			
2000 TO 4000	H	B	OUT	4,5,	IN	IN		A-11892-100	ADD			

NOTES FOR RANGE SELECTION TABLE 3:

1. Range polarity is positive (+XXX to +XXX) unless shown otherwise.
2. Jumper J3 (Bare Wire) is soldered in place unless specified otherwise.
3. R19 and D5 are OMITTED unless specified otherwise. If a JUMPER is specified for R19, use Bare Wire (47-414) as required.
4. Decimal Point Resistor R1 is NOT USED unless specified otherwise. Decimal Point position may be selected by adding Resistor R1 (22Ω, ±10%, ½W) as follows:

   For Decimal Point between DSP-4 and DSP-3, solder R1 into holes 1 and A on Digit Display Board.

   For Decimal Point between DSP-3 and DSP-2, solder R1 into holes 1 and B on Digit Display Board.
5. DPM Main circuit board A-11892-000 is used unless specified otherwise. A-11892-000 is a 4-digit DPM and A-11892-100 is a 5-digit DPM.
6. Display LED, DSP-1, is NOT REQUIRED unless specified otherwise. Adding DSP-1 will provide a 5-digit Display.
7. Digit enable transistors **Q2** and **Q3** are REQUIRED on Display circuit board A-11893. Clip-Out component only when specified.

DIGITAL INDICATOR KITS

DPM Kit Part Number	Description
71-607-1	4-Digit Indicator Kit (A-11892-000-1 DPM)
71-608-1	5-Digit Indicator Kit (A-11892-100-1 DPM)

Literature bulletin 1252/IN 60-1 describes the 4-Digit DPM Kit (71-607-1); and 1252/IN 61-1 describes the 5-Digit DPM Kit (71-608-1).

Replacement Digital Indicator assemblies are available in Kit form only. The A-11892-XXX-1 Indicator in each kit has been pre-tested and burned-in at the factory. The "-1" indicates assembly has been burned-in.

Customer must set-up Digital Indicator (as described in Range Selection Table 3) and calibrate DPM to his process range (see Field Calibration Procedure below).

FIELD CALIBRATION PROCEDURE

The following equipment is required for Calibration:

- Input mV Source (Barber-Colman PA Series Portable Potentiometer or equivalent).
- Extender Assembly (Part No. 24-2 for Models 521,2,3,4; or Part No. 24-3 for High Power Models 525,6,7,8).
- Range Code Calibration Table SPXX-X XXXX-XXX (SP15 or SP06 for Analog Setpoint and SP14 or SP05 for Digital Setpoint).

Proceed as follows:

1. Shorting Block jumpers (1 through 6), soldered wire jumpers (J1, J2, and J3), and selected components (D5 and R19) must be added or omitted as described in Range Selection Table 3 (see page 9) before performing the Calibration Procedure.

   Note: For ranges not listed, consult factory for correct jumper and component arrangement.

2. Connect the d-c millivolt input source to rear terminals 1 (+ plus) and 2 (- minus) on the 520 Series controller.

   Note: For thermocouple ranges, use appropriate thermocouple or thermocouple extension leadwire between millivolt source and controller. The NEGATIVE (-) wire is usually coded RED.

3. Remove the 520 Series controller from its housing and insert the proper Extender Assembly. Plug controller into Extender Assembly.
4. Turn power ON to controller.
5. Set the d-c millivolt source for the equivalent of about 20% of the Range temperature (observe cold-junction mV compensation procedure). Select this point from the Range Code Calibration Table, SPXX-X XXXX-XXX.
6. Adjust ZERO potentiometer R17 until the LED display indicates the equivalent DPM Reading ±1 digit (from the Range Code Calibration Table) for the temperature selected in step 5.
7. Set the d-c millivolt source for the equivalent of about 80% of the Range temperature (observe cold-junction mV compensation procedure). Select this point from the Range Calibration Table.
8. Adjust SPAN potentiometer R16 until the LED display indicates the equivalent DPM Reading ±1 digit (from the Range Code Calibration Table) for the temperature selected in step 7.
9. Interaction between ZERO and SPAN adjustments may occur. Repeat steps 5, 6,7, and 8 until desired accuracy is achieved and further adjustment is not required.
10. Seal ZERO (R17) and SPAN (R16) potentiometers.

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Models 521, 522, 523, and 524

4. ISOLATION BOARD CIRCUIT DESCRIPTION AND CALIBRATION

4.1 General

Isolation Board, A-11121-1, isolates the Process and Setpoint Output signals from the sensor input terminals. This input/output isolation makes these controllers extremely flexible in systems having multiple control loops.

Signal isolation is standard when Setpoint Option 2, 3, 5, 6, 7, or 8 is specified. Isolation Board, A-11121-1, is plugged into Main Board connector P6, and jumpers JA, JB, JC, JD, and JE on the Main Board are clipped.

4.2 Circuit Description

See Figure 4-1 for Isolation Board component assembly and schematic.

Preamplifier IC1 on an isolation version Main Board requires an isolated power supply. This is provided by an additional winding on Main Board power transformer, T1 (violet, violet-white), and regulated supply, IC4, on the Isolation Board.

The process signal (pin 6 of P6) is chopped via oscillator IC2 and switching transistor Q1. The square-wave level on output winding 1-2 (of Isolation Board transformer, T1) varies in proportion to the chopped signal on input winding 3-6. Feedback winding, 4-5, reduces distortion and improves linearity. The rectified-filtered DC voltage on output winding 1-2 goes through follower IC1A and appears as an isolated Process Output signal at pin 1 of P6.

Buffering is provided by followers IC3 for Setpoint Output and IC1B for Process Signal Output.

Isolated Process and Setpoint Output voltage is 1 to 5 Vdc.

Table 4-1. Isolation Board Adjustments

Potentiometer	Adjustment
R13	+15 Vdc Isolated Supply
R1	Input/Output Tracking

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Series 520
Troubleshooting Main Board and Range Boards, Changing Ranges

5. TROUBLESHOOTING

5.1 General

All of the Controller, except the preamplifier stage of IC1, can be troubleshot with a VOM of 20,000 ohms/volt sensitivity. Do not attempt to make major repairs on the Main Board. Minor repairs such as replacing broken pins may be made. Recalibrate the Main Board if you replace any critical component on it.

When making repairs on printed circuit boards or soldering transistor or integrated circuit terminals, use a 35 watt or less soldering iron and 63/37 or 60/40 resin core solder.

Following is a list of instruments for field troubleshooting the Controller.

Oscilloscope with calibrated sweep or equivalent (required to check waveforms).

Accurate DC Voltmeter

Strip Chart Recorder

In any general troubleshooting procedure, always do paragraph 5.2 first.

5.2 Power Supply Board

Measure all voltage outputs. If any part is replaced the controller must be completely recalibrated.

5.3 Excessive Drift of Either Setpoint or Process Temperature

The drift may be due to thermocouple deterioration. Thermocouple deterioration is usually found in a periodic inspection program. To determine thermocouple deterioration place the test thermocouple as close to the thermocouple under test as possible. If the output of the thermocouple under test differs from what is acceptable by the user (outside his or the manufacturer's specifications) then the thermocouple is defective.

Inspect thermocouple to leadwire and leadwire to controller connections to be certain they are covered properly so that air drafts across them are not affecting temperature indications by causing temperature gradients.

Measure the line voltage. It must be within the specified range.

5.4 Preamplifier IC1 and Range Board

Troubleshooting the Preamplifier stage of IC1 and the Range Board to which it is connected, requires battery operated voltmeters with input impedances of 10M ohms or higher.

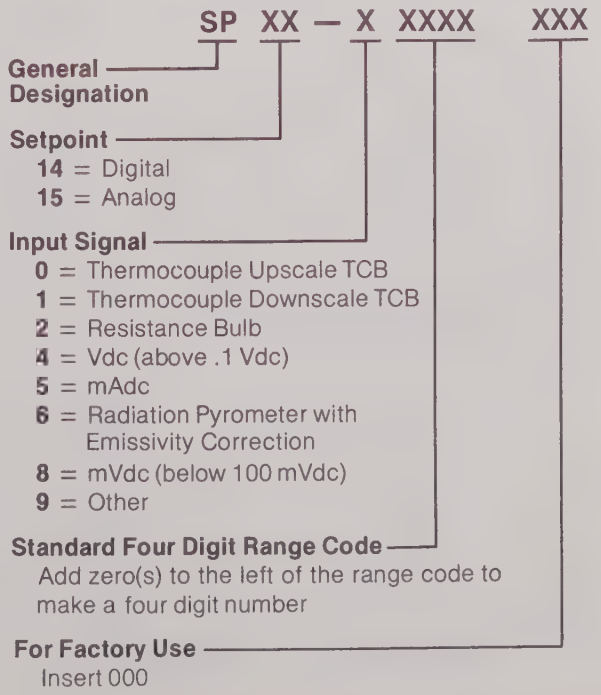
Battery operated test instruments with such an input impedance are the Hewlett-Packard Company Model 427A Multi-Function Meter and the John Fluke Manufacturing Company Model 871AB DC Differential Voltmeter. The remainder of the controller following the DC Amplifier may be troubleshot with a VOM with a 20,000 ohms/volt voltmeter or higher sensitivity.

5.5 Thermocouple Break Check

1. Disconnect any input (TC or dc millivolt source).
2. The Temperature Indicator should go full scale.
3. A milliammeter connected across the current output terminals should indicate zero.

5.6 Range Board Assemblies

Individual components on this assembly should not be replaced. When ordering a complete range board assembly, the following code must be written.


SP XX — X XXXX XXX
General Designation
Setpoint
14 = Digital
15 = Analog
Input Signal
0 = Thermocouple Upscale TCB
1 = Thermocouple Downscale TCB
2 = Resistance Bulb
4 = Vdc (above .1 Vdc)
5 = mAdc
6 = Radiation Pyrometer with Emissivity Correction
8 = mVdc (below 100 mVdc)
9 = Other
Standard Four Digit Range Code
Add zero(s) to the left of the range code to make a four digit number
For Factory Use
Insert 000

STANDARD RANGES FOR DIGITAL SETPOINTS AND FOR ANALOG SETPOINTS WITH SINGLE RANGE TEMPERATURE DIAL DIVISIONS

Thermocouple Ranges

Range	Code Number for Range and Thermocouple Type					
	J	K	R	S	B	Tungsten 5% Rhenium-Tungsten 26% Rhenium*
0–399°F	56					
0–499°F	306					
0–599°F	15					
0–799°F	16					
0–999°F	17	207				
0–1999°F		30	166	316		
0–2999°F			38	36	1814	
2000–3999°F						3382
200–799°F	751					
200–1199°F	203	2411				
500–1499°F	2980	3406				
1300–2299°F		3531				
0–399°C	22					
0–499°C	23					
0–599°C	24	110				
0–799°C		32				
0–999°C		33	276			
0–1999°C					3611	2552
200–1199°C		185	1597	3713		
500–1499°C			521	1395		3719

*No Symbol. Positive Wire is Hoskins Alloy 405. Negative Wire is Hoskins Alloy 426.

J—Iron Constantan K—Chromel Alumel R—Plat 13%
S—Plat 10% B—Plat 30% Rh/Plat 6% Rh

STANDARD RANGES FOR ANALOG SETPOINTS (°F AND °C) WITH DUAL RANGE TEMPERATURE DIAL DIVISIONS

The temperature range listed in column 1 is marked on the inner scale of the dial.

Thermocouple Ranges

Range	Code Number J
0–800°F	231
200–800°F	3644

RESISTANCE TEMPERATURE DETECTOR (RTD) RANGES

(100 ohm Resistance Bulb)

Range	Code
0 to 100°F	3550
0 to 100°C	4039
0 to 200°C	4119
0 to 400°F	1815
0 to 400°C	4022
0 to 600°F	4173
0 to 800°F	2345
200 to 800°F	4174

Range	Standard Millivolt Ranges-Uncompensated
0–9.99mV	381
0–49.9mV	1054
0–99.9mV	2892
–5 to 0 to + 5mV	1324*

*Available only with Analog Setpoint

STANDARD RANGES FOR ANALOG SETPOINTS WITH SINGLE RANGE TEMPERATURE DIAL DIVISIONS

Cryogenic (Low Temperature) Ranges

Range	J	T	100 RTD PT*
–400°F to 0°F	—	—	4164
–300°F to + 300°F	318	545	—
–100°F to + 100°F	—	—	4169

* The RTD range cards are calibrated for the ranges specified and apply to a 100 ohm (at 0°C) platinum element with a temperature coefficient of .00385 ohm/ohm/°C. Consult factory for other ranges and for sensors with other temperature coefficients.

5.7 Changing Ranges

5.7.1 IDENTICAL RANGES

Changing range boards with identical ranges is very easy. Unplug the old range board and plug in the new range board. The new range board is factory calibrated and no calibration is required.

5.7.2 CHANGING FROM ONE SPAN TO ANOTHER WITHIN THE SAME KIND OF RANGE

For example, suppose a 0–399°F range board is replaced by a 0–599°F range board.The digital setpoint will still be effective but only up to 399°F. The setpoint must be modified. Also, the 6 Vdc Process Signal Adjustment and the 3 Vdc Setpoint Voltage Adjustment on the Main Board must be adjusted. Don't forget that any process meter should be replaced.

5.7.3 CHANGING BOTH SPANS AND KINDS OF RANGES

For example, suppose a 0–399°F range board is replaced by a 0–49.9 mV range board. The digital set-

point must be modified. The 6 Vdc Process Signal Adjustment and the 3 Vdc Setpoint Voltage Adjustment on the Main Board must be adjusted. Any process meter scale must be replaced.

5.8 Setpoint Switch Assemblies

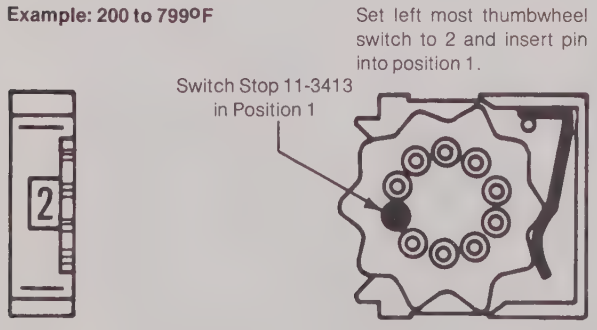
Digits	Part Number	Digital Span
3	A-10342-100	0–X99
3	A-10342-200	200–X99
3	A-10342-300	500–X99
3	A-10342-400	1300–XX99
4	A-10343	0–9999

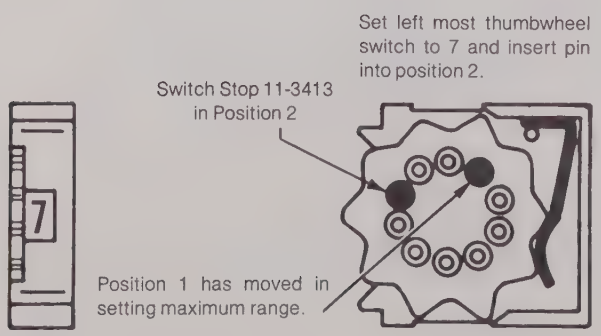
5.9 Modifying a 3-Digit Setpoint Assembly to Change its Range

To install the setpoint assembly, proceed as follows:

1. Hold modules and mounting cover together. Place one of the straps up from the bottom. Place second strap down with the short ends meeting the long ends. Short end should overlap on both sides and snap in place.
2. To set left most thumbwheel switch of the setpoint assembly (hundreds position) to minimum value of the required range, insert switch stop pin (part number 11-3413) into position 1. See example.
3. To set left most thumbwheel switch of the setpoint assembly (hundreds position) to the maximum value of the required range minus one, insert switch stop pin (part number 11-3413) into position 2. See example. Pins are not required for the ranges from 0 to 999.

Example: 200 to 799°F



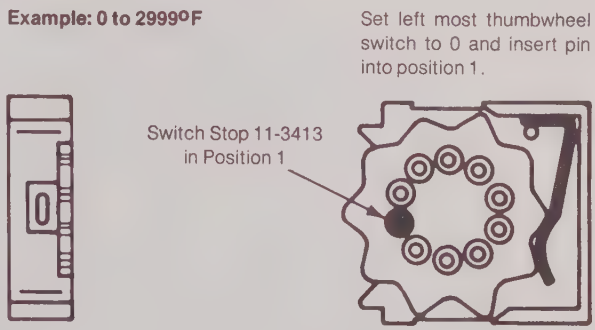

Set left most thumbwheel switch to 7 and insert pin into position 2.
Switch Stop 11-3413 in Position 2
Position 1 has moved in setting maximum range.
7

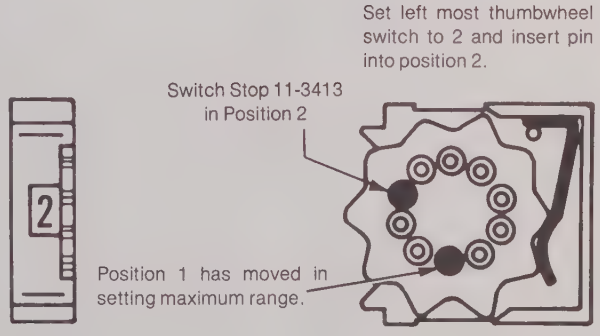
5.10 Modifying a 4-Digit Setpoint Assembly to Change its Range

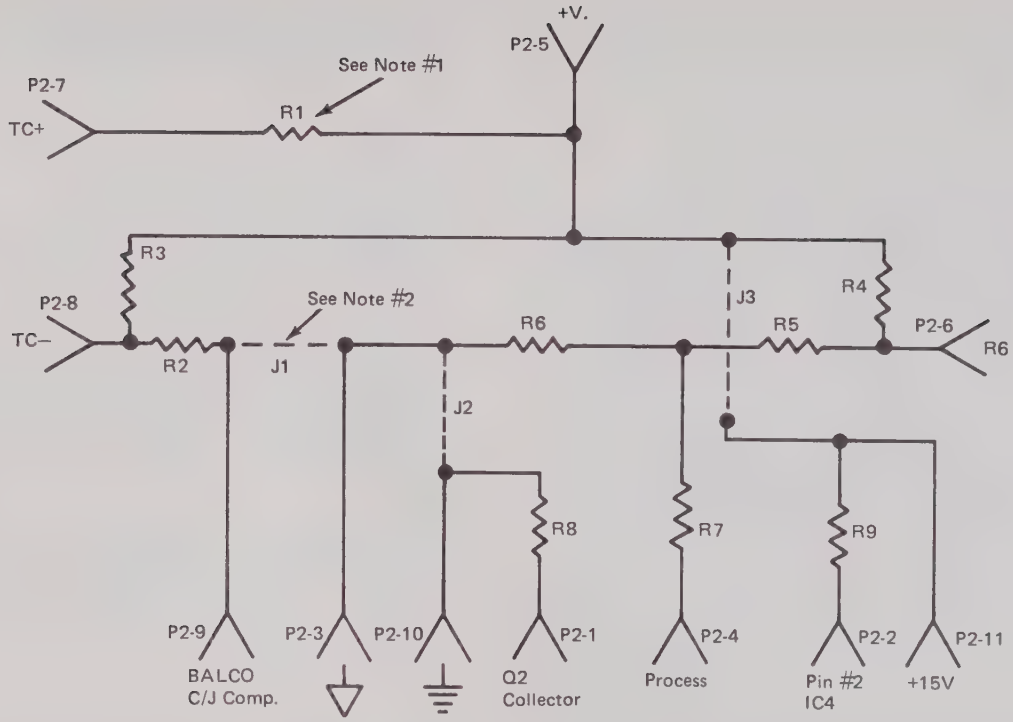
To install the setpoint assembly, proceed as follows:

1. Hold modules and mounting together. Place one of the straps up from the bottom. Place second strap down with the short ends meeting the long ends. Short end should overlap on both sides and snap in place.
2. To set left most thumbwheel switch of the setpoint assembly (thousands position) to the minimum value of the required range, insert switch stop pin (part number 11-3413) into position 1. See example.
3. To set left most thumbwheel switch of the setpoint assembly (thousands position) to the maximum value of the required range minus one, insert switch stop pin (part number 11-3413) into position 2. See example.

Example: 0 to 2999°F



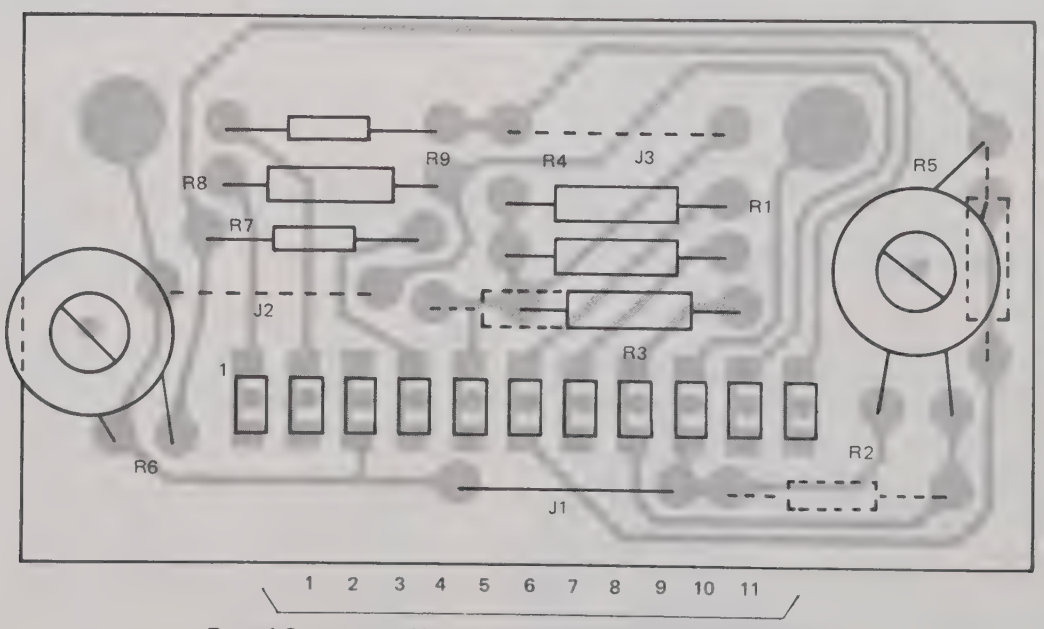

Set left most thumbwheel switch to 2 and insert pin into position 2.
Switch Stop 11-3413 in Position 2
Position 1 has moved in setting maximum range.
2



Notes

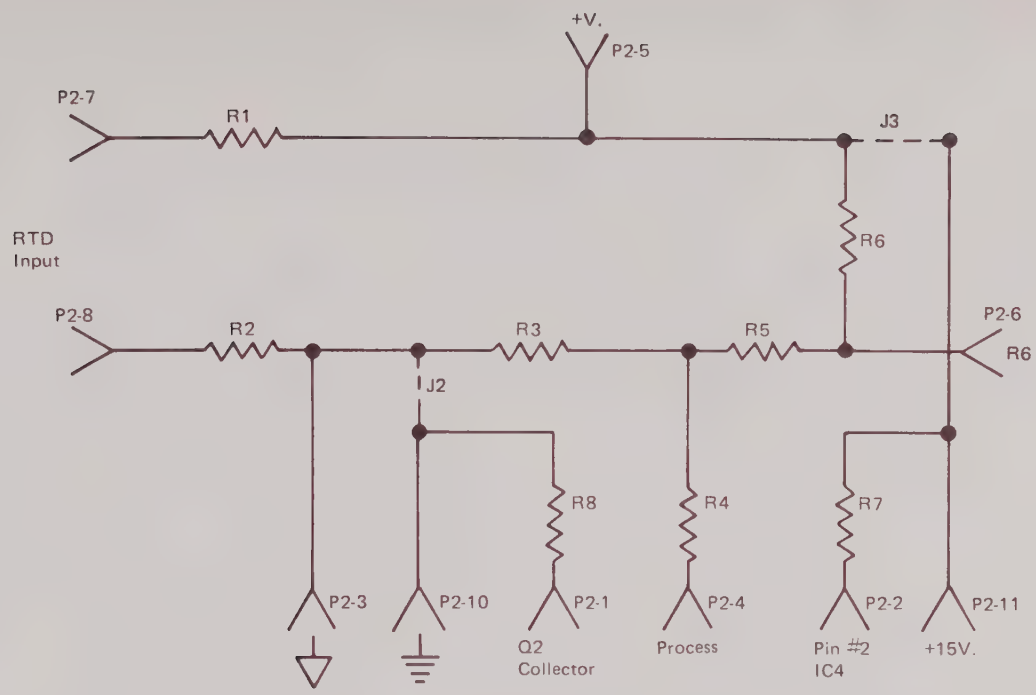
1. R1 is omitted for downscale TCB.
2. J1 is inserted for mV and Type B T/C ranges only.
3. J2 and J3 on SP05 and SP06.
4. R8 and R9 on Digital Setpoints.

R1 is the standard thermocouple break protection resistor. Resistors R2 and R5 set the required millivolt suppression to achieve the 2 to 10 Vdc process signal. R3 determines the current for the cold junction compensation by R2 on the Main Board. R6 and R7 are the preamplifier gain resistors. Resistors R8 and R9 are for span and suppression of the setpoint, respectively.



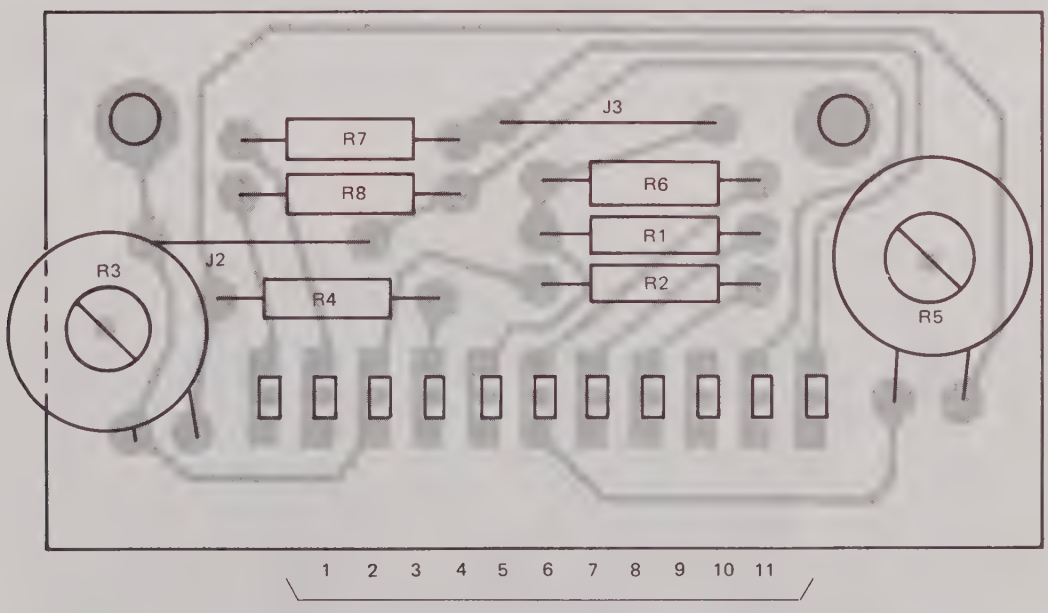
Board Connector Numbers—P2 Plugs Into Main Board

Figure 5-1. Thermocouple and Millivolt Range Board and Schematic



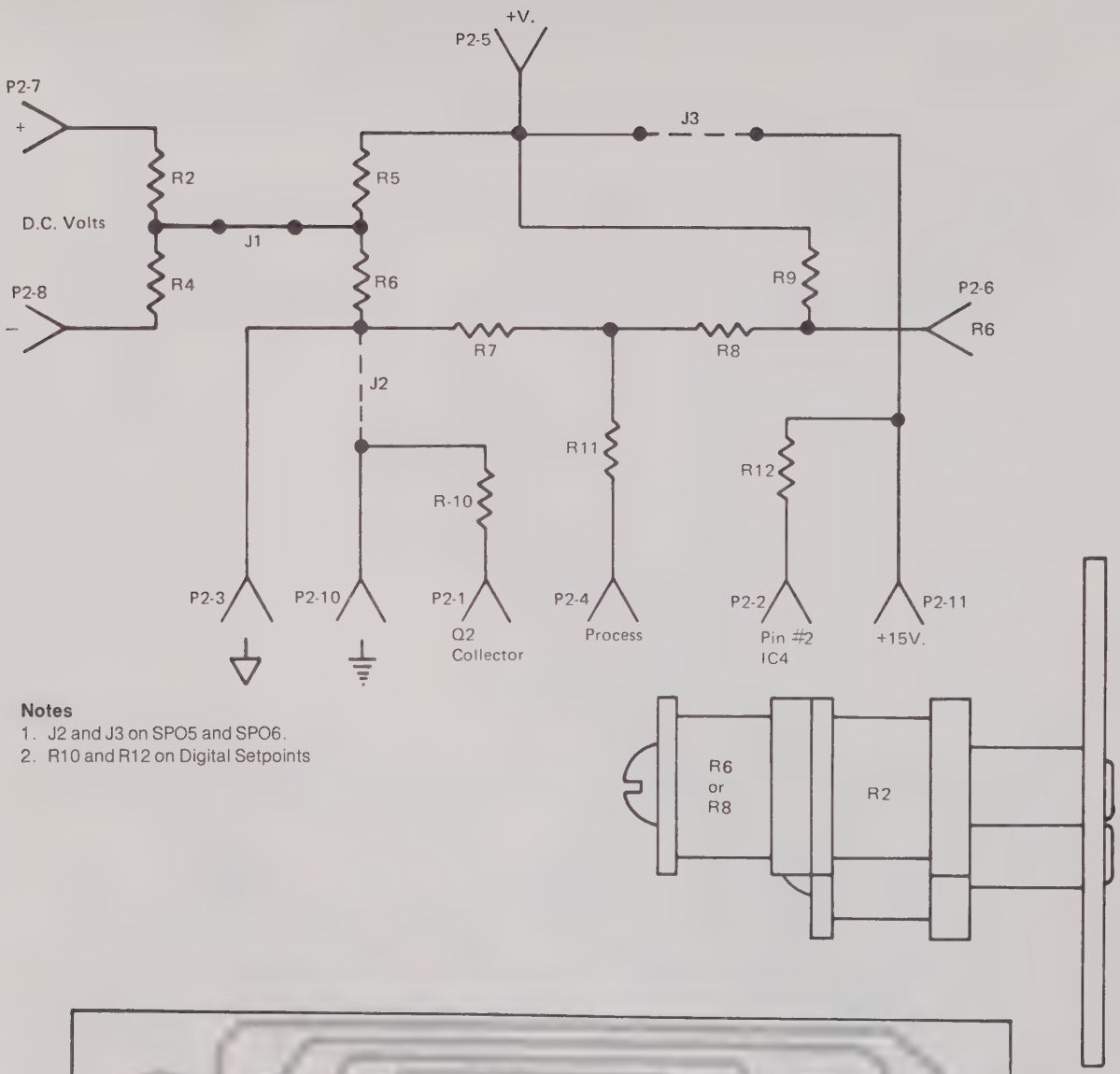
Notes

1. J2 and J3 on SPO5 and SPO6.
2. R8 and R7 on Digital Setpoints



Board Connector Numbers—P2 Plugs Into Main Board

Figure 5-2. Resistance Temperature Detector (RTD) Range Board and Schematic



Notes

1. J2 and J3 on SPO5 and SPO6.
2. R10 and R12 on Digital Setpoints

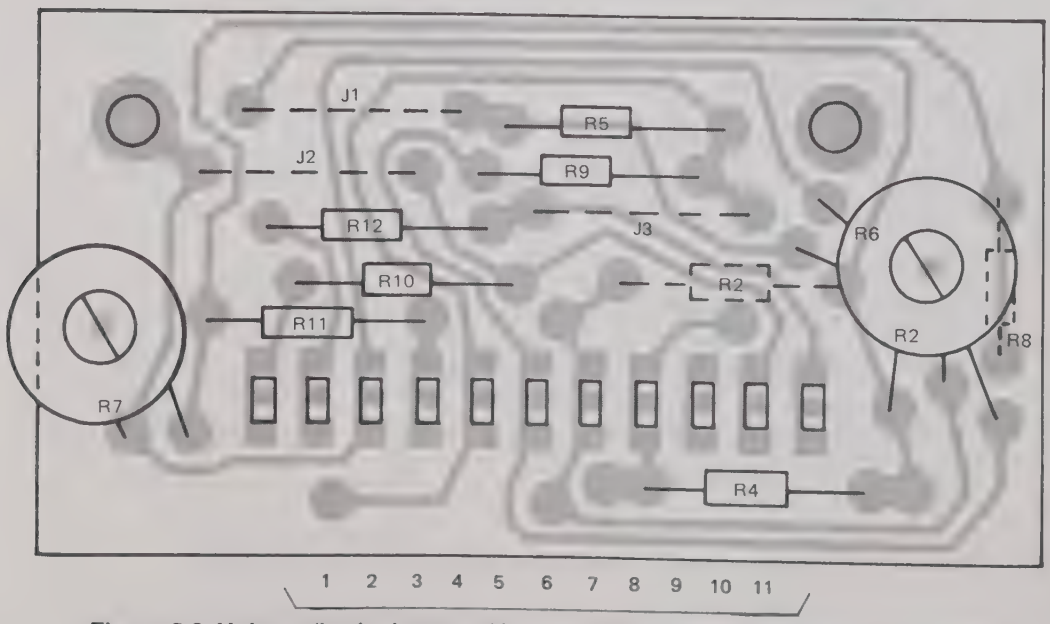
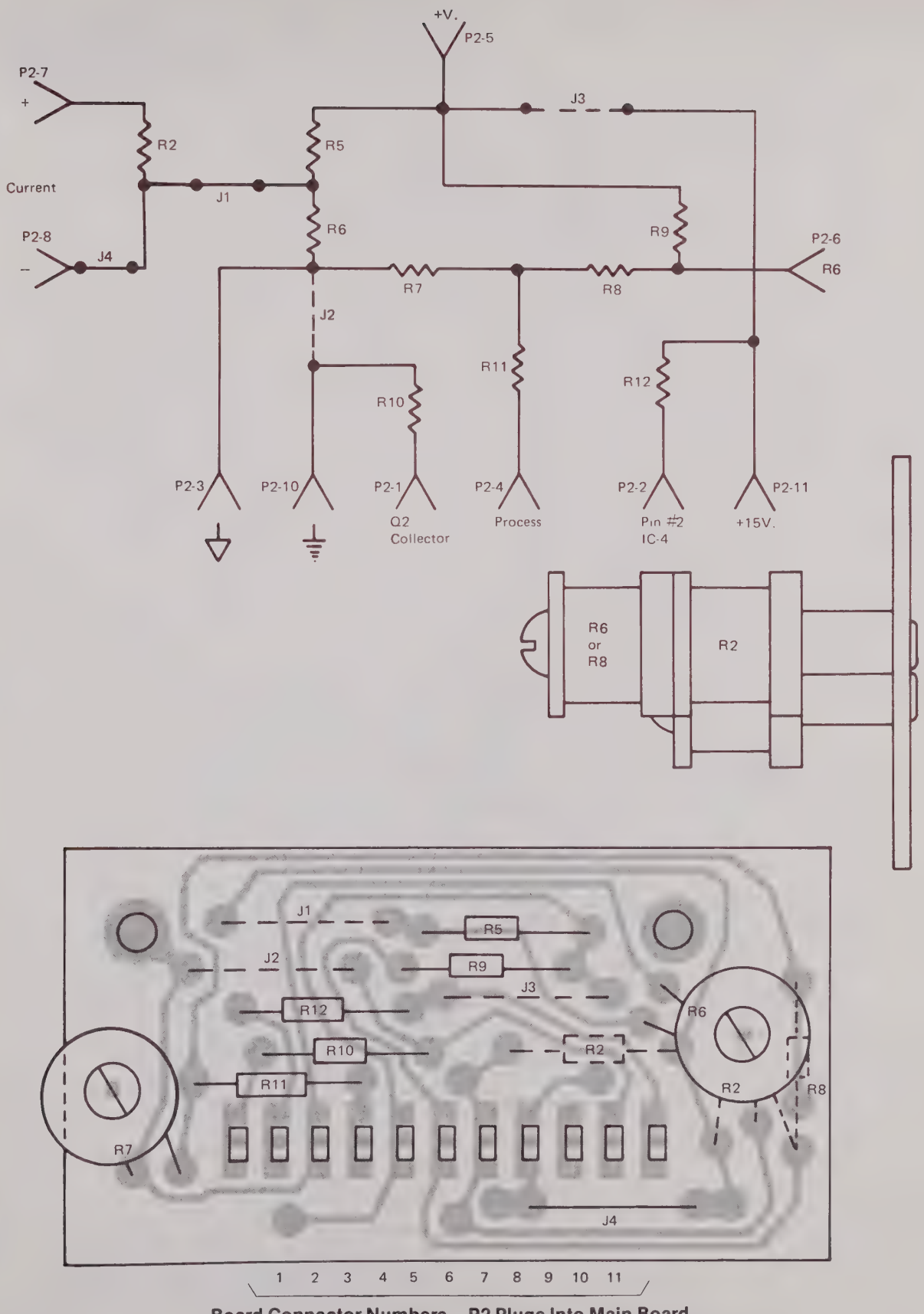


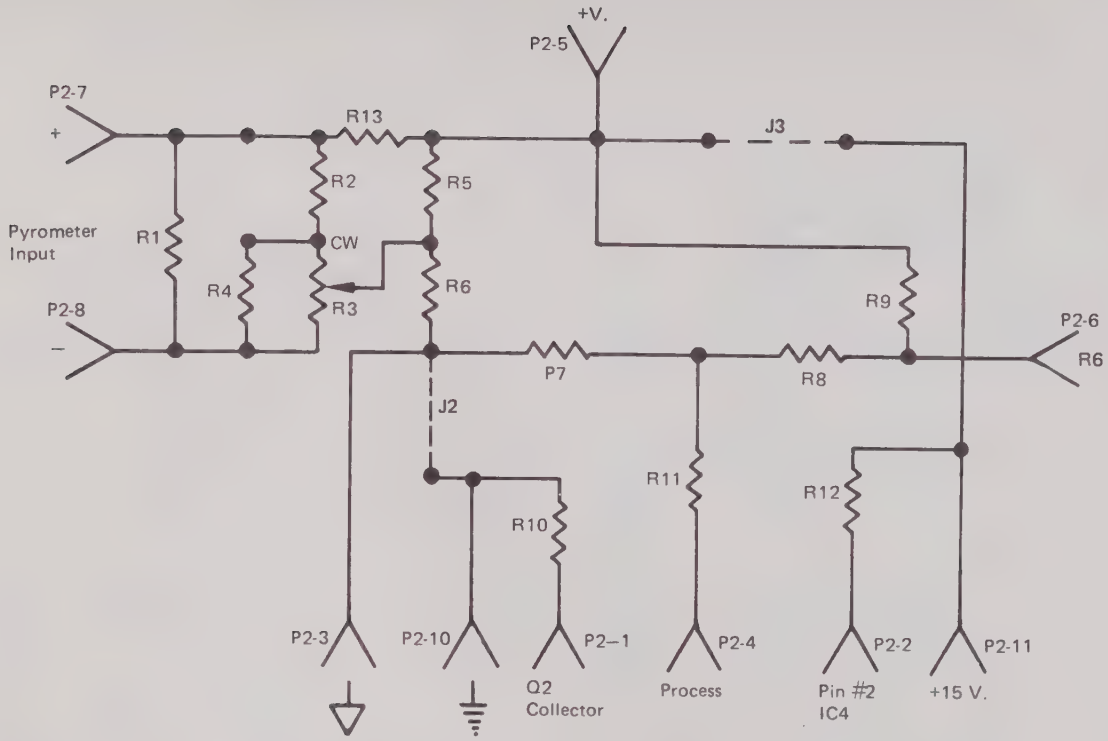
Figure 5-3. Voltage (both above and below .1 Vdc) Range Board and Schematic

Board Connector Numbers—P2 Plugs Into Main Board

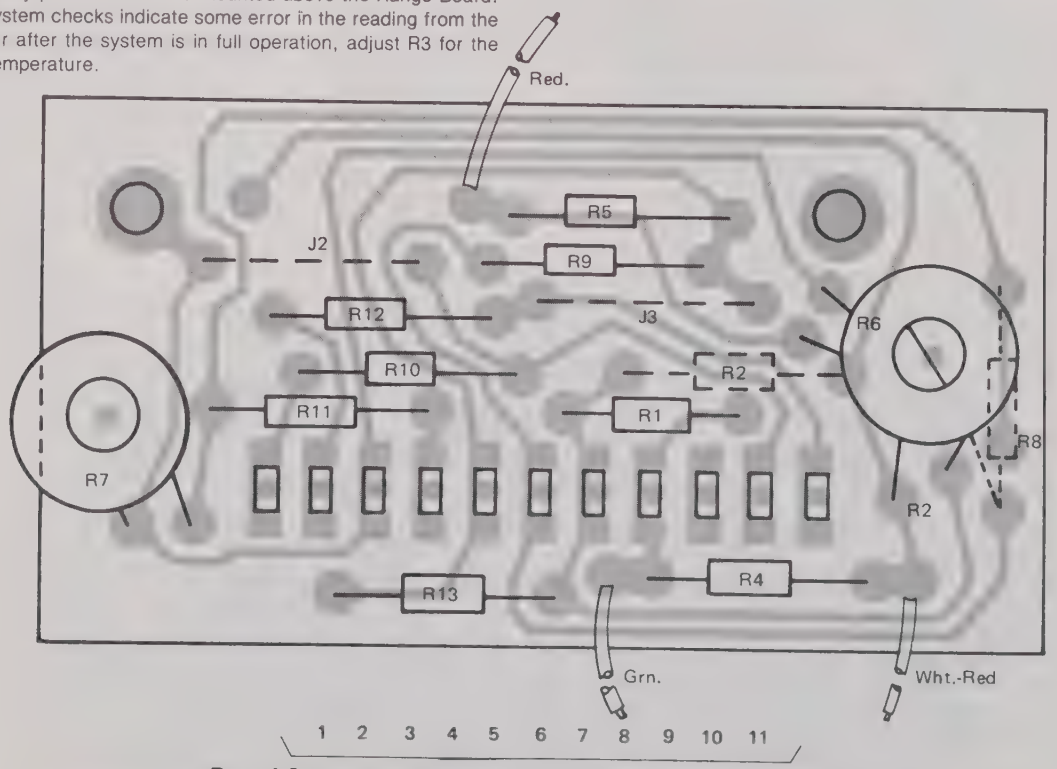


Board Connector Numbers—P2 Plugs Into Main Board

Figure 5-4. Current (mAdc) Range Board and Schematic



To Emissivity potentiometer R3 mounted above the Range Board. Should system checks indicate some error in the reading from the Pyrometer after the system is in full operation, adjust R3 for the correct temperature.



Board Connector Numbers—P2 Plugs Into Main Board

Figure 5-5. Radiation Pyrometer with Emissivity Correction Range Board and Schematic

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520 Series
6. ALARM BOARDS
Circuit Description And Service

6.1 GENERAL

Connections and adjustments for the Alarm Circuit are given in the Installation and Wiring Section for this manual. The alarm circuit is a simple voltage sensing circuit that drives a relay with an alarm contact rating of 2A at 120 Vac. The ALARM SET resistor R1 on the Main Board generates the reference voltage to which the process or deviation signal is compared at the input pins of IC1 on the alarm board. The ALARM SET resistor R1 is located at the upper left corner of the main board schematic, Figure 3-3.

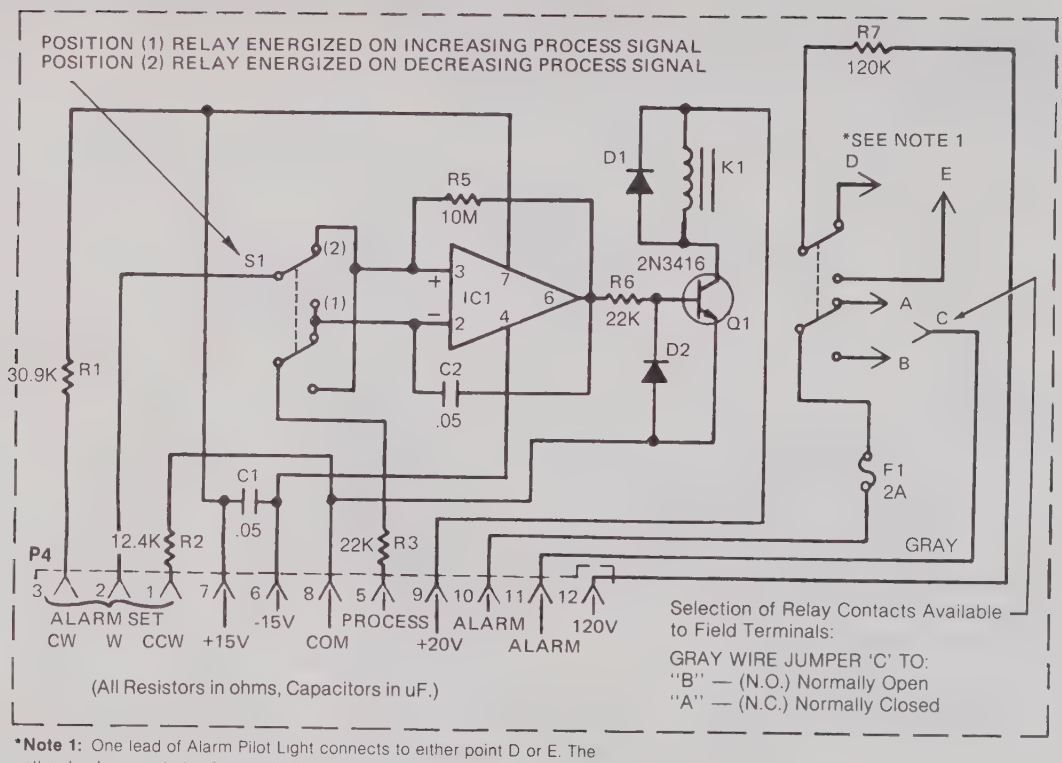
6.2 PROCESS AND DEVIATION ALARMS

The operation of both alarms is the same except for the input. The Process Signal input is on pin 5 on Figure 6-1. The Deviation Signal input is on pin 4 on Figure 6-2. If either the Deviation or Process Signal causes IC1 to turn on, the positive going output of IC1 turns on Q1, energizing K1. When K1 is energized, the front panel red alarm lamp goes off and remains off until IC1 turns off, deenergizing K1.

6.3 DEVIATION BAND ALARM

The Deviation Signal input is on pin 4 on Figure 6-3. IC1B and D1 form an "absolute value" circuit. The polarity of the "error" signal on the cathode of D1 always goes from 0 Vdc to a positive voltage with either a positive or a negative Deviation Signal on pin 4. The incoming Deviation Signal can swing to + 4 Vdc or to − 4 Vdc, depending on whether the process is above or below setpoint. The amplitude of the voltage on the cathode of D1 must always equal the amplitude of the voltage of the Deviation Signal. For example, if the Deviation Signal is either − 4 Vdc or + 4 Vdc, the voltage from the cathode of D1 to pin 8 (common) is + 4 Vdc in both cases. The "error" voltage on the cathode of D1 is compared with the alarm trip point voltage set by the ALARM SET resistor R1 on the Main Board. If the "error" signal causes IC1 to turn on, the positive going output of IC1 turns on Q1, energizing K1. When K1 is energized, the front panel red lamp goes off and remains off until IC1 turns off.

PROCESS ALARM



***Note 1:** One lead of Alarm Pilot Light connects to either point D or E. The other lead connects to pin 1 on the Main Board.

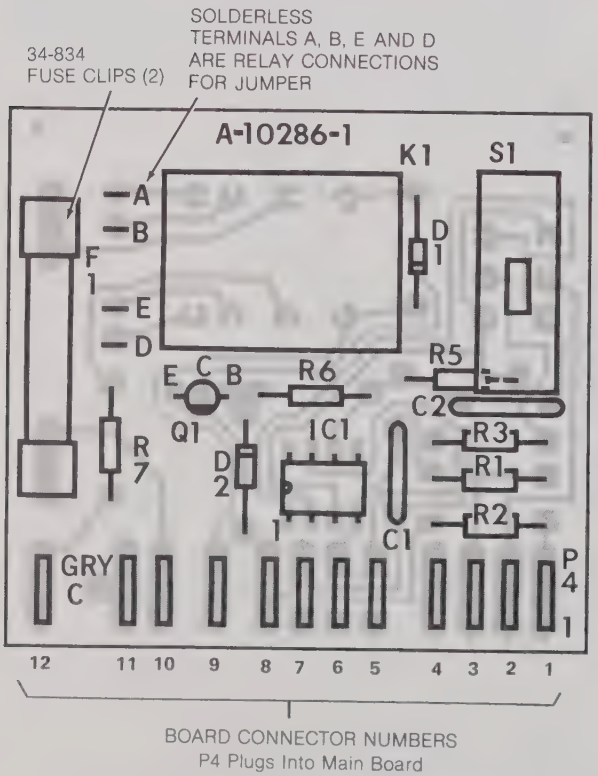
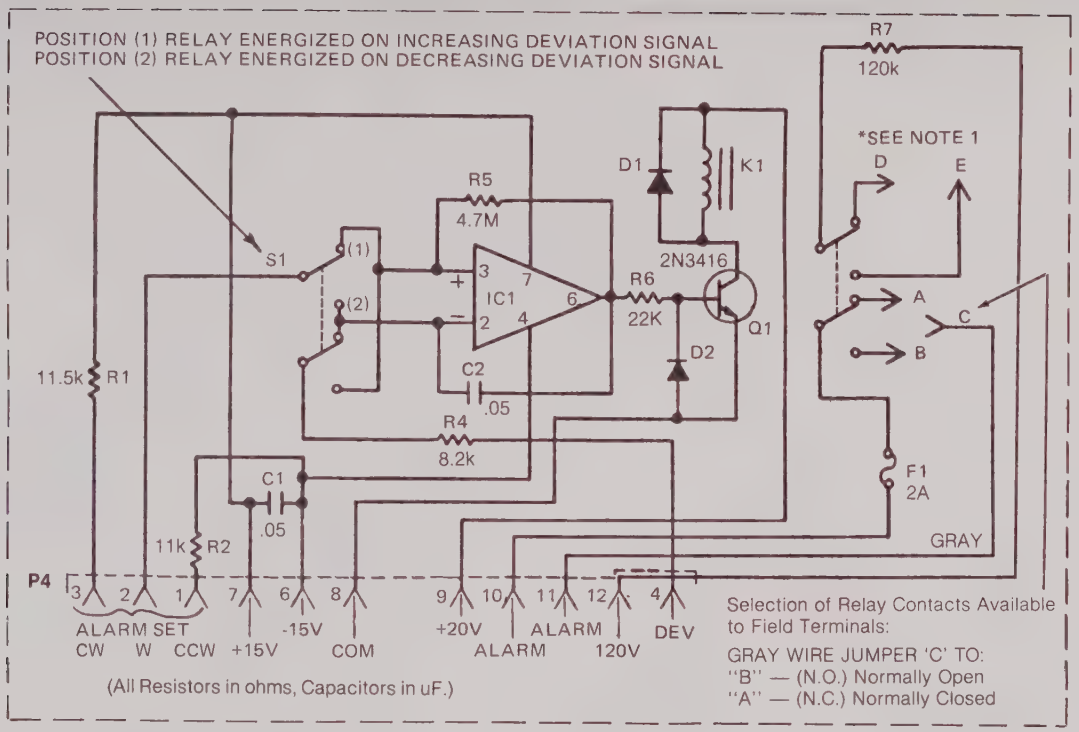


Figure 6-1. Process Alarm Board A-10286-1 and Schematic

Table 6-1. Process Alarm Board A-10286-1 Parts List

Symbol	Part Number	Description
		CAPACITORS
C1,2	39-325	.05uF, ±20%, 100 WVDC
		DIODES
D1,2	EYZP-384	250 PIV, If = 100 mA
		FUSE
F1	SYZE-206	2A, type AGC2
		INTEGRATED CIRCUIT
IC1	31-1012	741C Operational Amplifier
		RELAY
K1	38-205	DPDT, 20 Vdc, 12 mA
		TRANSISTOR
Q1	31-082	2N3416, NPN
		RESISTORS
		Resistors are ±10% tolerance, 1/4W, unless stated otherwise
R1	CYZR-861-348	30.9k ohms, ±1%, 1/8W
R2	CYZR-861-310	12.4k ohms, ±1%, 1/8W
R3	CYZR-836-334	22k ohms
R5	40-1871	10M ohms
R6	40-1950	22k ohms
R7	40-1706	120k ohms ±5%
		SLIDE SWITCH
S1	32-388	DPDT

DEVIATION ALARM



***Note 1:** One lead of Alarm Pilot Light connects to either point D or E. The other lead connects to pin 1 on the Main Board.

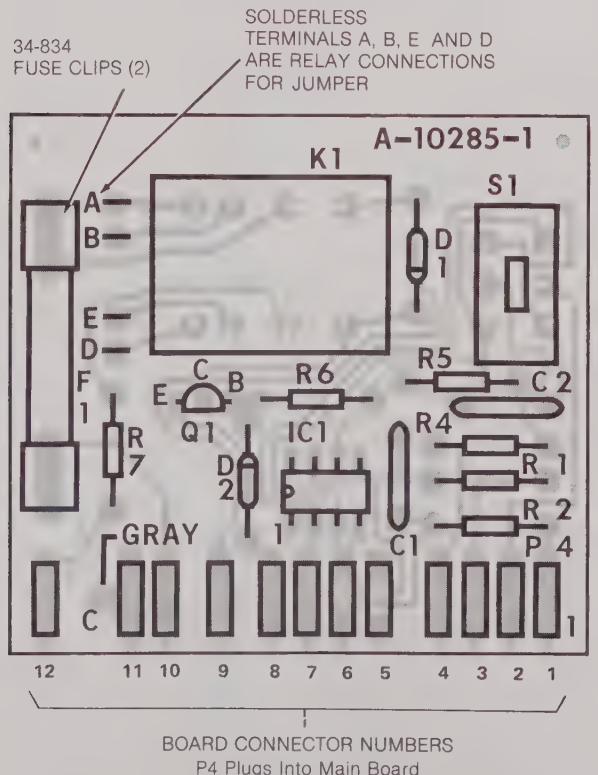
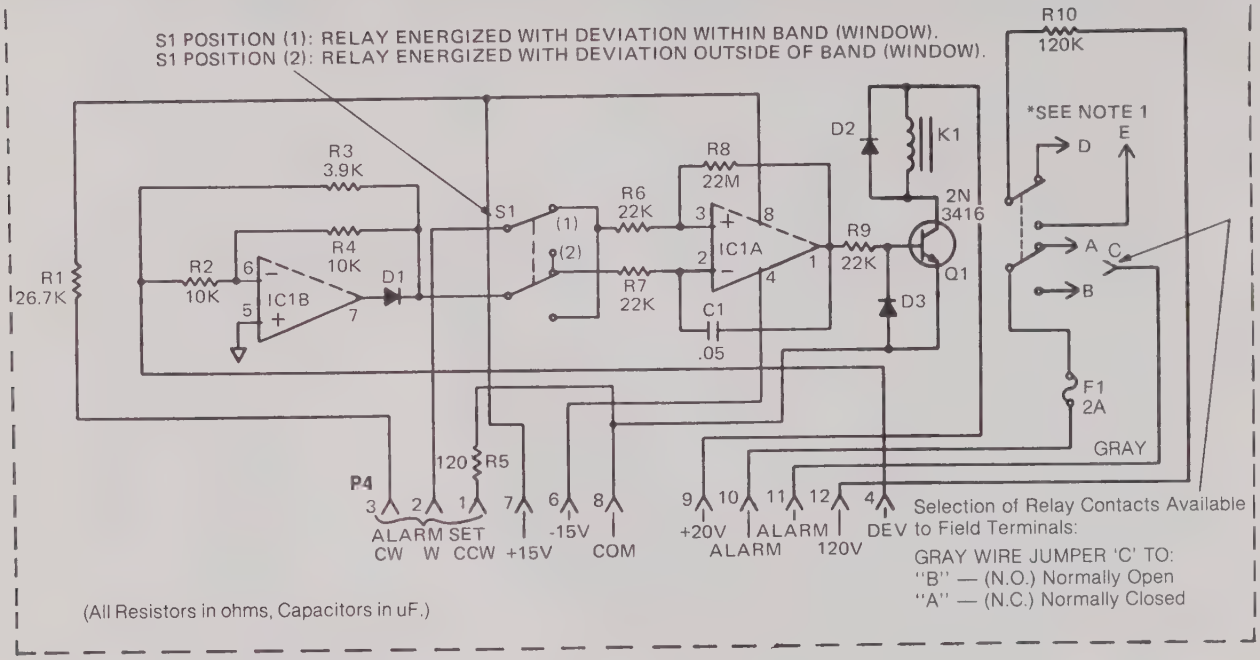


Figure 6-2. Deviation Alarm Board A-10285-1 and Schematic

Table 6-2. Deviation Alarm Board A-10285-1 Parts List

Symbol	Part Number	Description
		CAPACITORS
C1,2	39-325	.05uF, ±20%, 100 WVDC
		DIODES
D1,2	EYZP-384	250 PIV, If = 100 mA
		FUSE
F1	SYZE-206	2A, type AGC2
		INTEGRATED CIRCUIT
IC1	31-1012	741C Operational Amplifier
		RELAY
K1	38-205	DPDT, 20 Vdc, 12 mA
		TRANSISTOR
Q1	31-082	2N3416, NPN
		RESISTORS
		Resistors are ±10% tolerance, 1/4W, unless stated otherwise.
R1	CYZR-861-307	11.5k ohms, ±1%, 1/8W
R2	CYZR-861-305	11.0k ohms, ±1%, 1/8W
R4	40-1552	8.2k ohms
R5	40-1907	4.7M ohms
R6	40-1950	22k ohms
R7	40-1706	120k ohms, ±5%
		SLIDE SWITCH
S1	32-388	DPDT

DEVIATION BAND ALARM



***Note 1:** One lead of Alarm Pilot Light connects to either point D or E. The other lead connects to pin 1 on the Main Board.

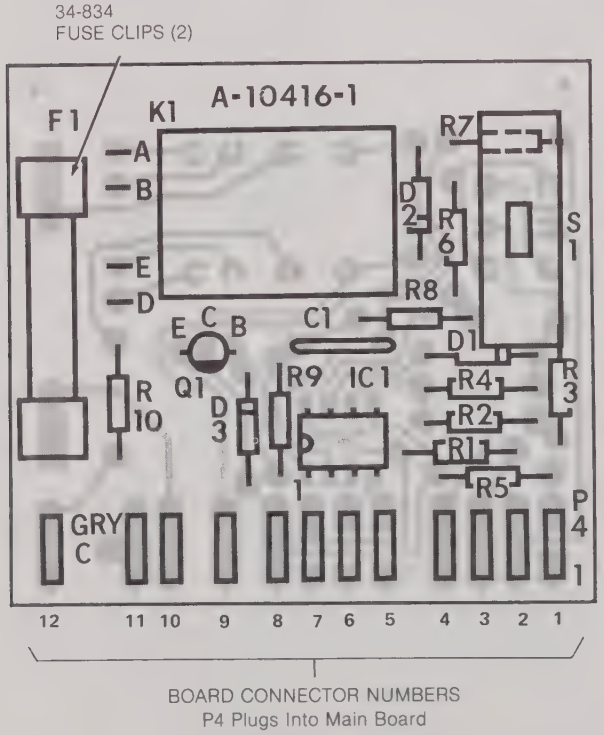


Figure 6-3. Deviation Band Alarm Board A-10416-1 and Schematic

Table 6-3. Deviation Band Alarm Board A-10416-1 Parts List

Symbol	Part Number	Description
		CAPACITOR
C1	39-325	.05uF, ±20%, 100 WVDC
		DIODES
D1,2,3	EYZP-384	250 PIV, If = 100 mA
		FUSE
F1	SYZE-206	2A, type AGC2
		INTEGRATED CIRCUIT
IC1	31-1015	Dual Minidip Operational Amplifier
		RELAY
K1	38-205	DPDT, 20 Vdc, 12 mA
		TRANSISTOR
Q1	31-082	2N3416, NPN
		RESISTORS
		Resistors are ±10% tolerance, 1/4W, unless stated otherwise.
R1	CYZR-861-342	26.7k ohms, ±1%, 1/8W
R2,4	CYZR-861-301	10k ohms, ±1%, 1/8W
R3	40-1557	3.9k ohms
R5	40-1758	120 ohms
R6,7,9	40-1950	22k ohms
R8	40-1857	22M ohms
R10	40-1706	120k ohms, ±5%
		SLIDE SWITCH
S1	32-388	DPDT

Barber-Colman Company
INDUSTRIAL INSTRUMENTS DIVISION
1700 Rock Street, Rockford, Illinois, U.S.A., 61101

520 Series
7. CONTROL MODE BOARDS
Circuit Description And Service

7.1 Proportional plus Integral plus Derivative Board A-10514

7.1.1 CIRCUIT DESCRIPTION

See Figure 7-1. The Derivative (RATE) Circuit generates a correction signal that is a time derivative of the input signal to the Operational Amplifier (error signal). Since the correction signal is a derivative with respect to time, the Derivative circuit is operative only when the input signal is changing.

The bias of FET Q1A, Q1B and Q2A, Q2B is adjusted by resistor R3. The integral (RESET) action is generated by R11 and C4. The range of RESET adjustment is from 0.06 to 6 repeats per minute by R11. Field Effect Transistors Q1A, Q1B and Q2A, Q2B are connected in an emitter follower-current source configuration. Emitter follower Q2A has the high input impedance required for long integrating time constants. Emitter follower Q1A has the high impedance required for the long derivative times. Derivative (RATE) time is adjusted from 0 to 3 minutes by R6. The derivative action is generated by R6, C2 and C3.

RESET INHIBITION occurs when the DEMAND signal (output on pin 6 of IC5 on the Main Board) on pin 1 of P3 goes to the positive limits of the proportional band. The voltage at which inhibition occurs varies with the output control form board; and, on the dual output control forms H, J and K, also with the GAIN RATIO setting. Part of the circuit which establishes the inhibition voltage is located on the output control form board.

For output control forms H, J and K; with a GAIN RATIO setting of 4:1, inhibition occurs at 2.4 Vdc (for 1:1 it occurs at 6 Vdc). The inhibition voltage varies proportionally with GAIN RATIO settings so that inhibition occurs near the positive limit of the proportional band.

When the limit voltage is exceeded, a transistor on the output board turns on, which turns on control mode board transistor Q3 and reduces the voltage across R11 and C4 to 0.6 Vdc.

For all other output control forms, a resistor on the output control form board establishes the correct inhibition voltage (+6 Vdc).

The effect of the inhibition circuit action is to clamp the Integral(RESET)action to zero when the DEMAND signal exceeds the proportional band. This prevents excessive charge from accumulating on C4 during the time the controller is outside its proportional band. As the process signal again enters the proportional band, the output drops below 100% and normal circuit action is restored.

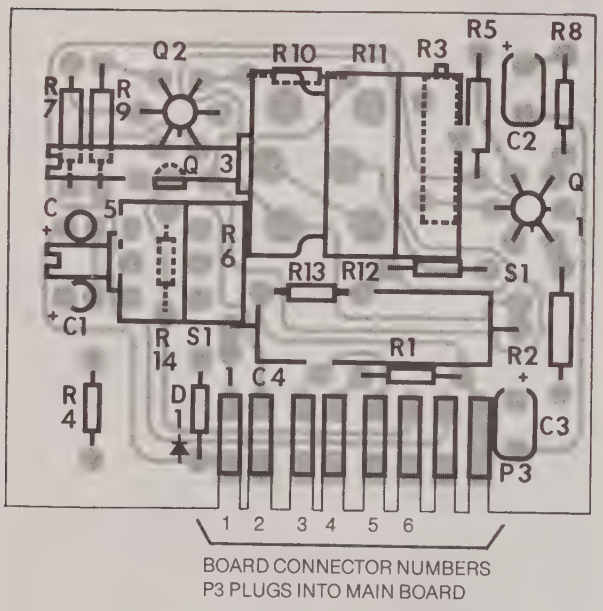
7.1.2 CALIBRATION OF FIELD EFFECT BIAS

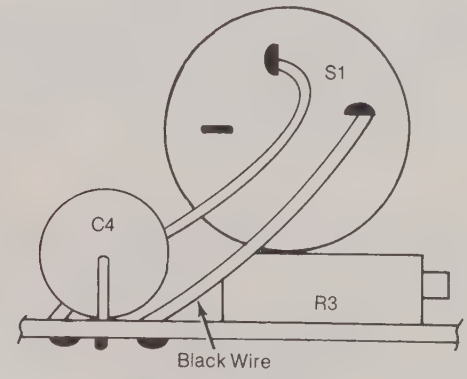
Adjustments on the Main Board need not precede this adjustment.

1. Unplug the Output Control Form Board from P5.
2. Short pins 1, 2, and 7 of P5 on the Main Board.
3. Turn off the front panel RESET control fully CCW to the OFF position.
4. Connect a precision digital voltmeter from the wiper of R3 to pin 7 of P5.
5. Adjust R3 until 0 Vdc ±.0001 Vdc is obtained.
6. Remove the shorting jumpers from pins 1, 2 and 7 of P5 and plug in the Output Control Form Board.
7. Allow power to remain on to the instrument and then perform any required adjustments for the Output Board Circuit, Section 8 of this manual.

Table 7-1. Parts List, Proportional Plus Integral Plus Derivative Board A-10514

Symbol	Part Number	Description
		CAPACITORS
C1,5	39-442	4.7 uF, ±20%, 20 WVDC
C2,3	39-437	68 uF, ±20%, 15 WVDC
C4	E13-89	10 uF, ±20%, 50 WVDC
		DIODE
D1	EYZP-384	250 PIV, I_f = 100mA
		TRANSISTORS
Q1A, 1B, and Q2A, 2B	31-157	2N3956, Factory selected dual FET
Q3	EYZP-623	2N4126
		RESISTORS
Resistors are ±10% tolerance, 1/4W, unless stated otherwise		
R1	CYZR-481-300	220 ohms
R2	CYZR-862-201	1k ohms, ±1%
R3	29-390	Variable, 1k ohms, ±10%, 3/4 W
R4,13	40-1847	47k ohms
R5,7,9	CYZR-862-218	1.5k ohms, ±1%
R6	29-334-1	RATE pot, dual, 5M, 0.5M, ±20% 1/5W
R8,10,14	40-1314	100k ohms
R11	29-372-1	RESET pot, dual 50M, ±30%, 1/2 W
R12	40-1763	1M, ±10%
		ROTARY SWITCH
S1		SPDT, Part of R11





View of S1 Wiring

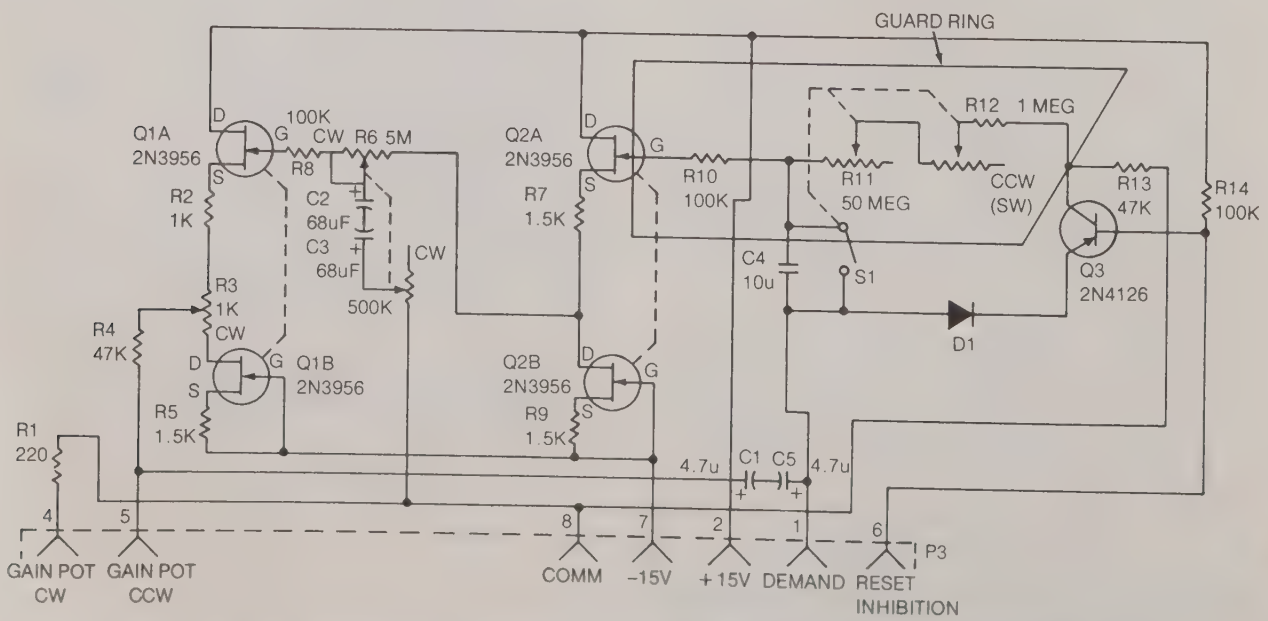


Figure 7-1. Proportional Plus Integral Plus Derivative Board A-10514 and Schematic

7.2 Proportional plus Integral Board A-10281

See Figure 7-2. The bias of FET Q1A and Q1B is adjusted by resistor R2. The integral (RESET) action is generated by R6 and C2. The range of RESET adjustment is from 0.06 to 6 repeats per minute. Field Effect Transistors Q1A and Q1B are connected in an emitter follower-current source configuration. The emitter follower has the high input impedance required for long integrating time constants. RESET INHIBITION occurs when the DEMAND signal (output on pin 6 of IC5 on the Main board) on pin 1 of P3 goes to the positive limits of the proportional band. The voltage at which inhibition occurs varies with the output control form board; and, on the dual output control forms H, J and K, also with the GAIN RATIO setting. Part of the circuit which establishes the inhibition voltage is located on the output control form board. For single output controllers, inhibition occurs at +6 Vdc on pin 1 of P3.

For output control forms H, J and K; with a GAIN RATIO setting of 4:1, inhibition occurs at 2.4 Vdc (for 1:1 it occurs at 6 Vdc). The inhibition voltage varies proportionally with GAIN RATIO settings so that inhibition occurs near the positive limit of the proportional band.

When the limit voltage is exceeded, control mode board transistor Q2 turns on, reducing the voltage across R6 and C2 to 0.6 Vdc.

The effect of the inhibition circuit action is to clamp the Integral (RESET) action to zero when the DEMAND signal exceeds the proportional band. This prevents excessive charge from accumulating on C2 during warm-up or on increase in setpoint. As the process signal again enters the proportional band, the output drops below 100% and normal circuit action is restored.

7.2.2 CALIBRATION OF FIELD EFFECT BIAS

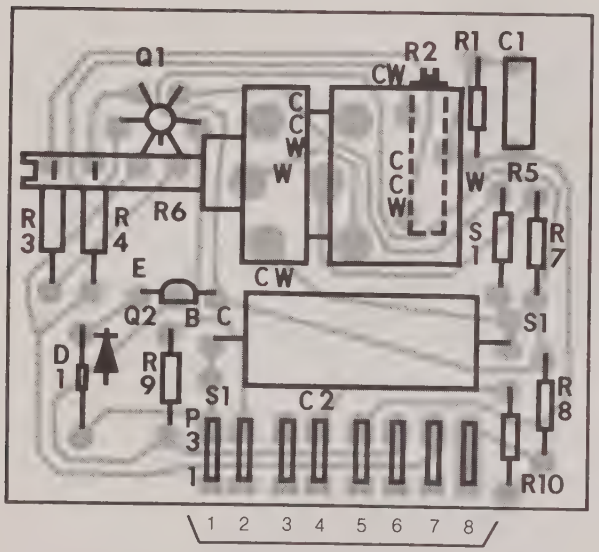
Adjustments on the Main Board need not precede this adjustment.

1. Unplug the Output Control Form Board from P5.
2. Short pins 1, 2, and 7 of P5 on the Main Board.
3. Turn off the front panel RESET control fully CCW to the OFF position.
4. Connect a precision digital voltmeter from the wiper of R3 to pin 7 of P5.
5. Adjust R3 until 0 Vdc ± .0001 Vdc is obtained.
6. Remove the shorting jumpers from pins 1, 2 and 7 of P5 and plug in the Output Control Form Board.
7. Allow power to remain on to the instrument and then perform any required adjustments for the Output Board Circuit, Section 8 of this manual.

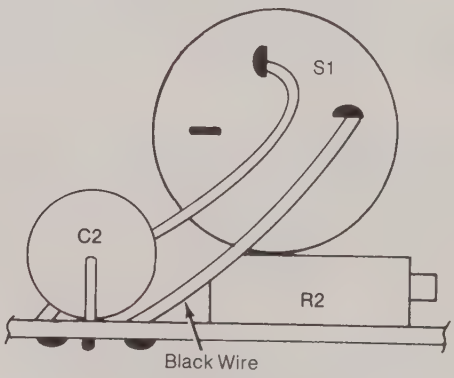
Table 7-2. Parts List, Proportional plus Integral
Board A-10281-1

Resistors are ±10% tolerance, 1/4 W unless stated otherwise.

Symbol	Part Number	Description
		CAPACITORS
C1	CYZR-803	.1 uF, ±20%, 250 WVDC
C2	E13-89	10uF, ±20%, 50 WVDC
		DIODE
D1	EYZP-384	250 PIV, I_f = 100mA
		TRANSISTORS
Q1A,B	31-157	2N3956, Factory Selected dual FET
Q2	EYZP-623	2N4126
		RESISTORS
R1,8	40-1847	47k ohms
R2	29-376	Variable, 500 ohms, 3/4W
R3	CYZR-862-209	1.21k ohms, ±1%
R4	CYZR-862-218	1.5k ohms, ±1%
R5,9	40-1314	100k ohms
R6	29-372-1	RESET pot, dual 50M, ±30%, 1/2W
R7	40-1763	1M, ±10%
R10	CYZR-481-300	220 ohms
		ROTARY SWITCH
S1		SPDT, Part of R6



BOARD CONNECTOR NUMBERS P3 PLUGS INTO MAIN BOARD



View of S1 Wiring

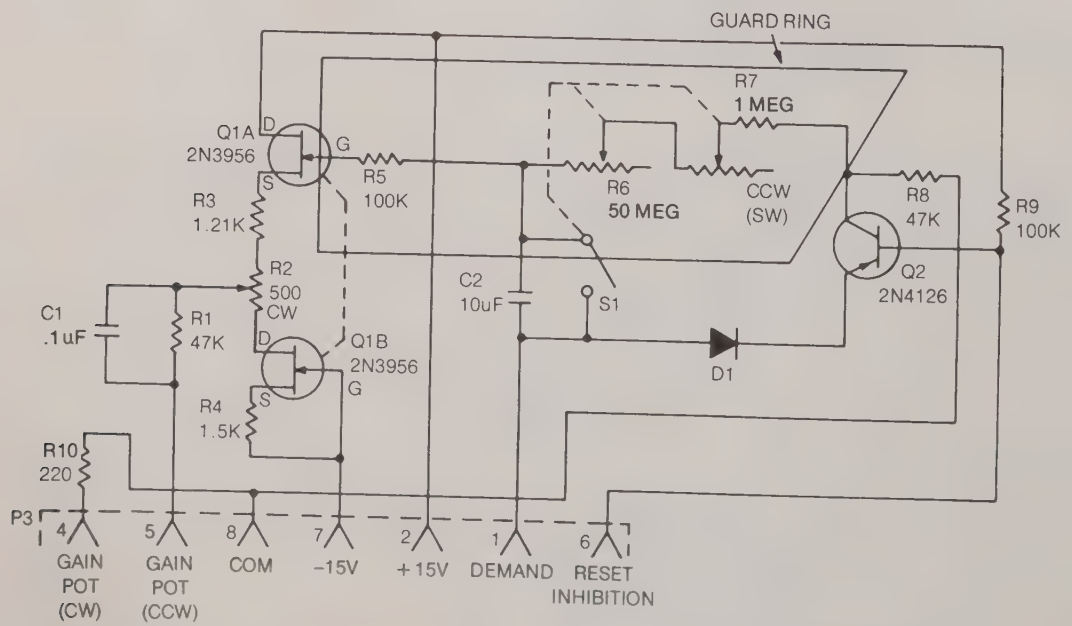


Figure 7-2. Proportional Plus Integral Board A-10281-1 and Schematic

7.3 Proportional Plus Manual Reset Board A-10280 Circuit Description

See Figure 7-3. The front panel MANUAL RESET resistor drives the output control form board from full off to full on when the controller is at zero deviation. Resistors R1 and R4 on this board and R23 on the Main Board determine the gain of the controller.

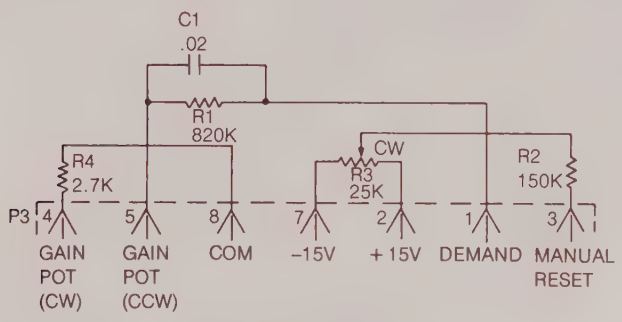
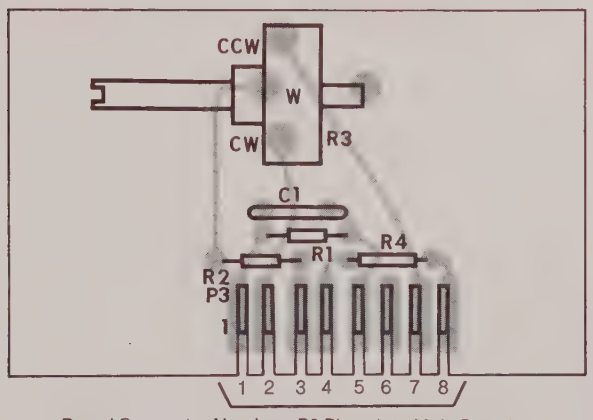


Figure 7-3. Proportional plus Manual Reset Board A-10280 and Schematic



Board Connector Numbers P3 Plugs Into Main Board

Table 7-3. Parts List, Proportional Plus Manual Reset Board A-10280

Symbol	Part Number	Description
		CAPACITORS
C1	39-416	.02uF, GMV, 600 WVDC
		RESISTORS
Resistors are ±10% tolerance, 1/4 W, unless stated otherwise.		
R1	CYZR-836-489	820k ohms
R2	40-1813	150k ohms
R3	29-371	RESET pot, 25k ohms, ±30%, 1/2 W
R4	CYZR-836-243	2.7k ohms

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F-14852-5 BK JULY 1979

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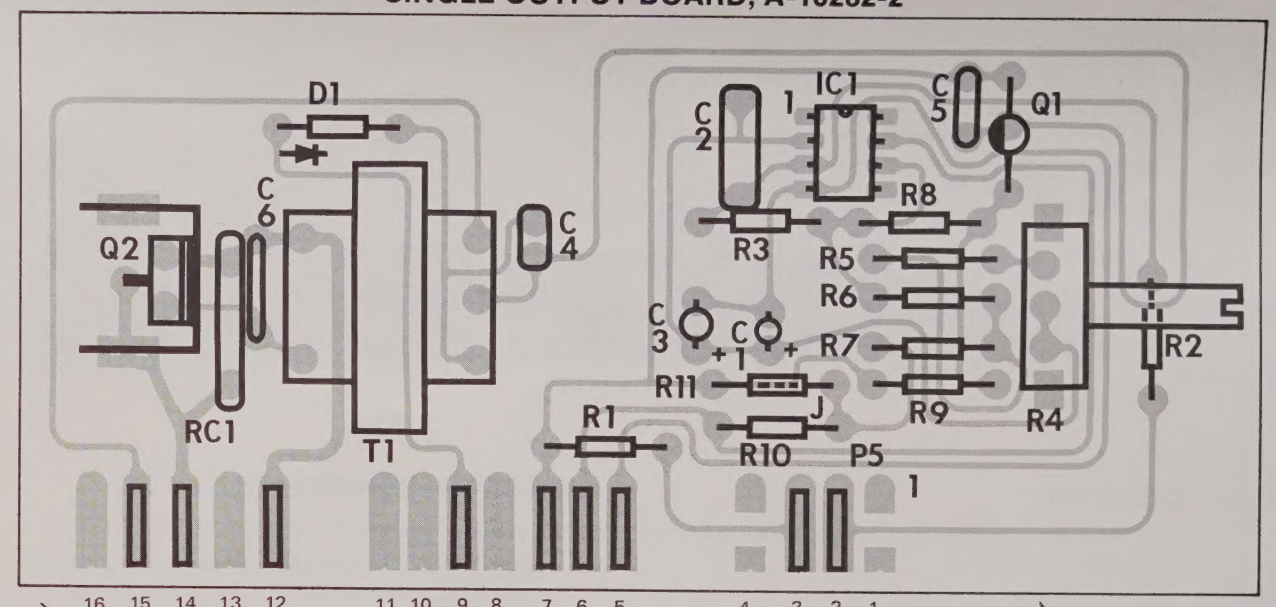
Table 8-1. Parts List, Single Time-Proportioning Solid State Switching Output Board A-10282-2

Symbol	Part Number	Description
		CAPACITORS
C1	39-382	1μF, ±20%, 35 WVDC Tantalum
C2	CYZR-803	0.1μF, ±20%, 250 WVDC Mylar
C3	39-431	10μF, ±10%, 35 WVDC Tantalum
C4	39-076	250pF, ±20%, 500 WVDC Ceramic
C5	39-063	.001μF, GMV,* 600 WVDC Ceramic
C6	39-325	.05μF, ±20%, 100 WVDC Ceramic
		*Guaranteed Minimum Valve
		DIODE
D1	EYZP-384	250 PIV, I_f = 100 mA
		INTEGRATED CIRCUIT
IC1	31-1012	741C Operational Amplifier
		TRANSISTORS
Q1	31-082	2N3416 NPN Silicon
Q2	31-155	Triac, Factory Selected, either RCA 40669 or GE SC 146D
		RESISTORS
		Resistors are ±10% tolerance, 1/4W composition, unless otherwise stated.
R1	CYZR-481-200	56k ohms
R2	40-1568	68k ohms
R3	40-1314	100k ohms
R4	29-373-1	2M ohms ±30%, 1/5W, Potentiometer (CYCLE TIME)
R5	40-1917	180k ohms
R6	CYZR-862-326	18.2k ohms, ±1%, 1/4W, 100 ppm Metal Film
R7	CYZR-862-356	37.4k ohms, ±1%, 1/4W, 100 ppm Metal Film
R8	40-1950	22k ohms
R9	40-1842	1.8k ohms
R10	—	Omit
R11	47-028	Wire Jumper
RC1	50-1196	Transient Suppressor
		TRANSFORMER
T1	30-323-1	Pulse

SINGLE OUTPUT BOARD, A-10282-2



BOARD CONNECTOR NUMBERS
P5 Plugs Into Main Board

Enlarged circuit board image shown with Bottom-Side foil pattern.

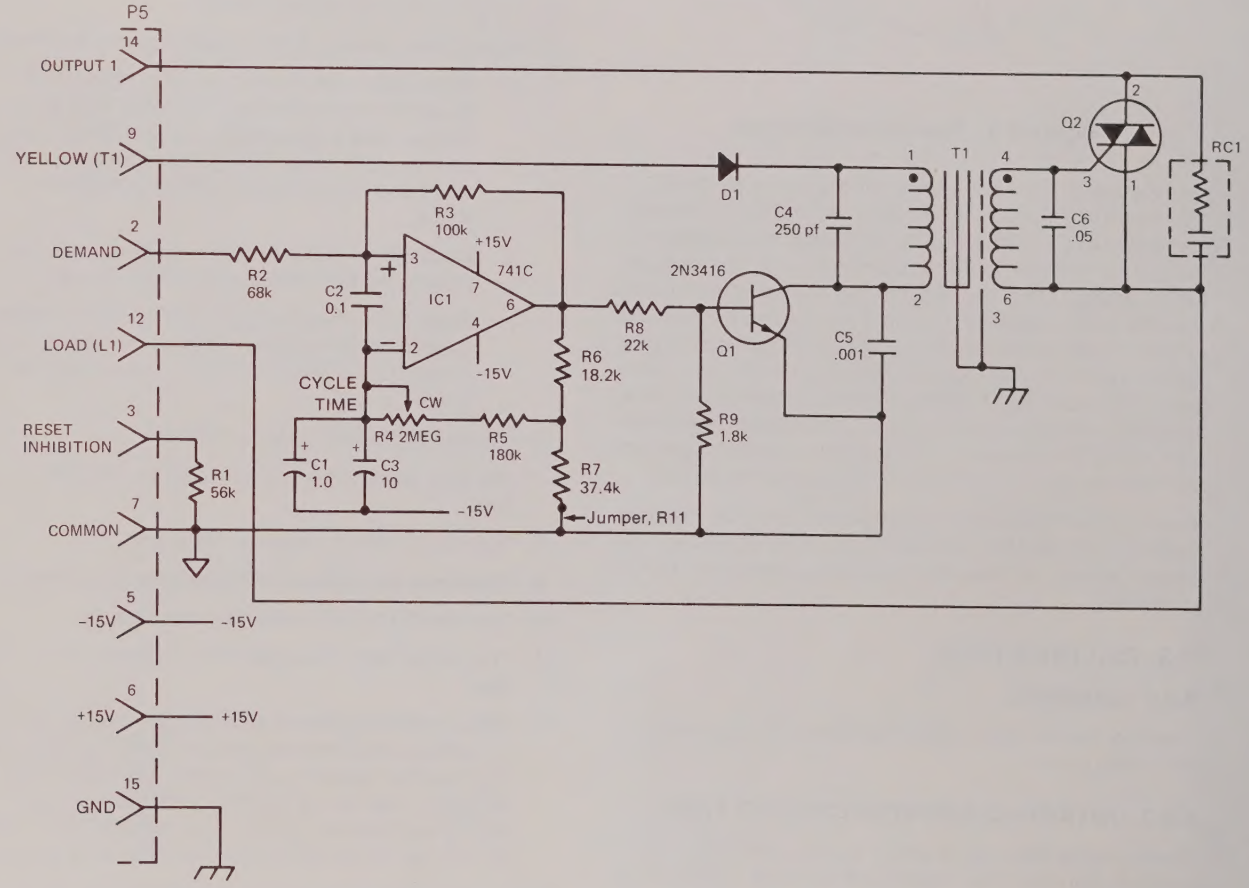


Figure 8-2. Single Time-Proportioning Solid State Switching Output Board A-10282-2 and Schematic

Models 522B, 523B, and 524B

8. OUTPUT BOARD CIRCUIT DESCRIPTION and SERVICE

This is the last section of Service Manual 1252 IN 22.

8.1 GENERAL

The circuit description, calibration and troubleshooting follow in paragraphs 8.2, 8.3, and 8.4.

8.2 CIRCUIT DESCRIPTION

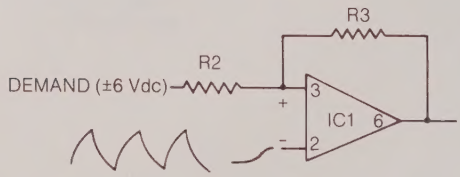


Figure 8-1. Triangular Waveform

See Figures 8-1 and 8-2. The demand signal on pin 2 of P5 is compared to a triangular waveform voltage. This waveform is generated by C1, C3, R4, and R5, and appears between terminal 2 of IC1 and the -15 Vdc on pin 5 of P5. When the Demand Signal on pin 3 of IC1 exceeds the maximum amplitude of the waveform, the output of IC1 on pin 6 approaches the potential of the +15 Vdc supply, causing Q1 to turn ON, and causing the gate signal to turn ON Triac Q2. The rating of Q2 is 1A continuous, 20A inrush, 50mA minimum. When the Demand Signal is less than the minimum amplitude of the waveform (the condition calling for no power to the load), the potential on pin 6 of IC1 approaches -15 Vdc, causing Q1 and Q2 to turn OFF.

Fuse F1 on the Main Board is in series with Triac Q2. The fuse is rated 2A at 250 Vac. Fuse size must not be exceeded. The copper foil on the Main Board will be destroyed at higher currents.

8.3 CALIBRATION

8.3.1 GENERAL

The front panel CYCLE control R4 is the only adjustment on this output board.

8.3.2 OBTAINING A FASTER CYCLING TIME

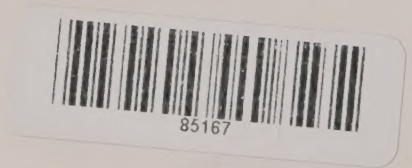
Potentiometer R4 is set to obtain a cycle time from 6 to 60 seconds nominal. This adjustment of cycle time can be changed to 0.6 to 6 seconds by either removing capacitor C3 or clipping one lead of C3. The faster cycling rate will enable optimum control with a solid state contactor.

8.4 TROUBLESHOOTING

For an overall inspection of this board, proceed as follows:

1. Connect a load to the output terminals that require a current of 50 mAdc or more. The front panel Amber lamp will not turn OFF unless the load has this minimum current.
2. Connect a dc millivolt source to controller rear panel input terminals 1 and 2. Be certain the polarity of the connections is correct. Adjust source for equivalent of midscale temperature.
3. Turn power ON to the controller.
4. Turn the GAIN control fully CCW.
5. Now perform either a, b, or c, depending upon the model.
   a. Model 522 — Short pins 1 and 7 of P5 on the Main Board. Connect a VOM between pins 2 and 7 of P5 on the Main Board. Adjust the front panel RESET control until the VOM reads 0 Vdc. Remove the short from pins 1 and 7 of P5. Disconnect the VOM. Proceed to step 6.
   b. Model 523 — Turn the front panel RESET control fully CCW to the OFF position. Proceed to step 6.
   c. Model 524 — Turn the front panel RESET control fully CCW to the OFF position. Turn the front panel RATE control fully CCW to the OFF position. Proceed to step 6.
6. Turn the SETPOINT control to midspan.
7. The front panel Amber lamp should be ON 50% of the time.
8. Turn the SETPOINT control to full scale.
9. The Amber lamp should be ON more than 90% of the time.
10. Turn the SETPOINT control to minimum scale.
11. The Amber lamp should be OFF more than 90% of the time.
12. If the correct indication is not obtained in steps 7 through 11, connect the VOM between pins 2 and 7 of P5. If both the following indications are correct, the output board is defective. Turn the SETPOINT control to full scale: the VOM should indicate +6 Vdc. Turn the SETPOINT control to minimum scale: the VOM should indicate -6 Vdc.

Do not depend on fuse F1 on the Main Board to protect Triac Q2; the primary purpose of the fuse is to protect the copper foil on the Main Board.



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